CHAPTER D.10
REGIONAL STRATEGIES FOR COASTAL RESTORATION IN LOUISIANA: BARRIER ISLANDS AND MAINLAND SHORELINES

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10.1 Summary

This chapter presents specific strategies for restoring the Louisiana barrier shoreline. The strategies presented represent possible long-term restoration features that go beyond the near-term priority restoration features recommended in the main report. Additionally, the level of detail provided for these strategies are conceptual in nature and are provided as a guide for possible future restoration activities The strategies are offered for consideration by the LCA Team as restoration of specific coastal segments projects evolve. Strategies are presented for the following areas: the Chandeleur Islands, the Plaquemines shoreline, the Caminada-Moreau Headland and Grand Isle, the Timbalier Islands, the Isles Dernieres, Point au Fer to Freshwater Bayou, Freshwater Bayou to Calcasieu Pass, and the Calcasieu-Sabine Shoreline. The inclusion of references to the subprovinces as defined in the main report are included to aid the reader.

10.2 Introduction

Regional strategies should view Louisiana's barrier shoreline as a series of coastal barriers that can be maintained for the foreseeable future. Almost every coastal engineering project (nourishment or structures) needs periodic monitoring and maintenance. For restoration programs that use the introduction of sediments as the main restoration strategy, the maintenance interval (renourishment) will depend on the initial construct design lifetime. This, in turn, is mainly a function of the volumetric density used to restore the island. For planning purposes, we suggest a renourishment interval of 10 years. The barrier islands are composed of sands and mixed fine sediments (silts, clays), and maintenance programs need to consider replacement of both types of sediment. The restoration should be divided in two main components: (1) the introductory nourishment, to restore the coast to desired templates, and (2) an advanced fill (maintenance) nourishment component. After the project lifetime is achieved, erosion losses will be replaced in the approximated quantity of advanced fill. Monitoring the performance of individual barrier shoreline components is critical to restoration success.

The purpose of initial or introductory nourishment is to build the islands to a critical mass (minimum cross-section), restore weak spots (historical overwash locations) along the islands, and plug former bayside access channels that are likely to breach (due to Gulfside shoreline retreat) in order to construct an island of relatively uniform elevation. Minimum design cross-sections are presented in this section for the barrier islands of the Chandeleur, Plaquemines, and Lafourche systems, as well as the Isles Dernieres. These cross-sections are calculated based on measured island cross-sections (Louisiana Geological Survey - Ritchie et al. 1989, 1990, 1992, 1995). Advanced fill/maintenance requirements are calculated herein, based on practices presented in the Best Management Practices and Coastal Sediment Restoration Tools chapters.

Barrier islands should be monitored for volumetric performance through time, and nourished on a scheduled periodic basis. Periodic nourishment requirements (maintenance) will be smaller than initial nourishment requirements. Refinement of the volumetric estimates presented in this chapter can be achieved over time by using monitoring data for the entire active profile of constructed projects. This data can be used to evaluate project performance and identify erosional hot spots.

Template height should be a function of project objectives, as discussed in the Construction and Design Template chapter. Typically, nourishment projects should consist of four main components: (1.) a seaward beach berm; (2.) enhanced dune; (3.) backbarrier marsh platform restoration/construction, and (4.) vegetative plantings. Structures may be used to improve performance of specific project sites.

Two design approaches are considered in this section to calculate the volumetric densities presented. A stabilized design with predominantly sand fill (less than 10% silt) and a retreat design with mixed sediments (sand fill for Gulf and mixed fine sediment for marsh) (Figure D.10-1). Two other design options (stabilized design with coastal structures and retreat design with predominantly sand sediments) are introduced, but their respective volume densities are not calculated (Figure D.10-1).

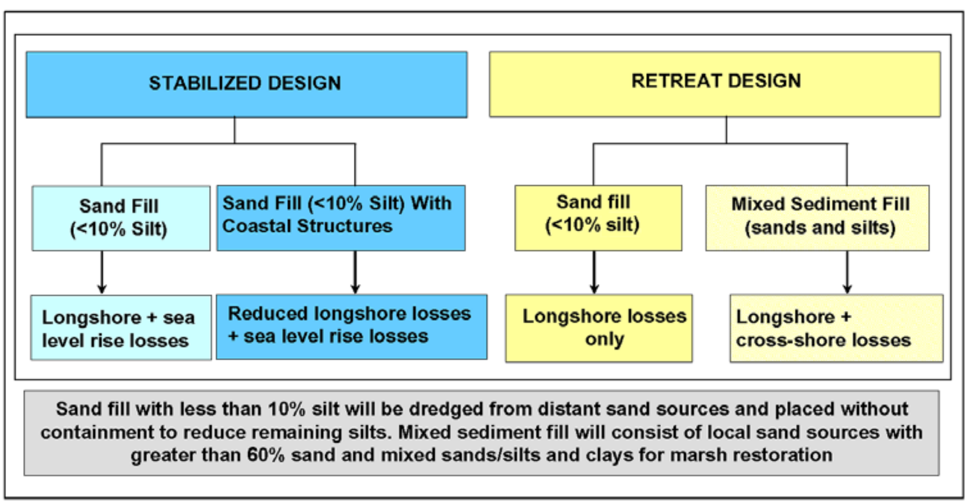

Figure D.10-1. Flow chart illustrating the four design approaches proposed to restore Louisiana barrier islands.

The stabilized design requires higher initial volumes and clean sands, but maintenance needs will be reduced because shoreline retreat will be restricted by the high sediment density (higher templates) and predominance of sand (less than 10% silt) in the restored island. In the stabilized design scenario, the main losses of beach fill are due to longshore processes and sea-level rise.

If the location of a barrier shoreline is stabilized, enough sediment to counteract sea-level rise (in addition to longshore losses) must be provided. Assuming a relative sea-level rise rate of 1 cm/yr (Penland and Ramsey 1991), a 1 cm thick layer of sediment over the footprint of the entire active profile is needed to maintain the island. The volume of sediment necessary to achieve this objective is about 2.0 to 2.5 cy/ft/yr in Louisiana, which is equivalent to about 20 to 25 cy/ft in a 10 year renourishment cycle. The volume necessary to counteract sea-level rise must be provided to stabilize the shoreline in order to avoid shoreline submergence. If current losses of a retreating barrier shoreline are significantly less than this range, island stabilization is not economically beneficial. On the other hand, if current losses of a retreating island are significantly higher than this range, stabilization is an economically sound option.

The retreat design with mixed sediments will require smaller initial volumes than the stabilized design. However, maintenance needs will be greater due to the occurrence of both cross-shore and longshore losses after restoration. The retreat design must also account for sea-level rise because the island is retreating (in response to sea-level rise) to higher substrate elevations. This causes a loss of fine sediments, but conserves sand. The use of stabilizing coastal structures can potentially reduce the longshore losses on stabilized shorelines. Structures should be used if two conditions are met: (1) the structures cost less than the fill that is preserved by their introduction, and (2) downdrift effects are negligible.

The retreat design with predominantly sandy sediments would have the lowest volumetric loss rate because sand would be conserved in the cross-shore rollover process. The use of sand sediments with a small percentage of fines (Ship Shoal sands) would have a higher cost and may not be ideal for planting marsh species. Because of the potential optimum performance of this option, further conceptual model development and prototype testing is encouraged. The four design approaches are presented in Figure D.10-1.

In this chapter, volumetric and cost estimates for the construction of retreat designs and stabilized designs are presented for each coastal segment. Local interests, project objectives, and economic considerations will ultimately be used to select the most suitable option. The construction of retreat design templates will enhance existing shoreline cross-section to conform to design (minimal) cross-sections; advanced fill would provide enough sediment volume to preserve this minimal cross-section for the project lifetime (10 years). Overwash, however, will not be prevented on low shorelines, and shoreline retreat will continue at the long-term historic rate. The construction of stabilized designs with advanced fill will produce new shorelines with higher elevations and will provide enough sediment in the form of advanced fill to sustain this template for the project lifetime (10 years). Overwash will be significantly reduced in these high template scenarios, and the rate of shoreline retreat should slow down.

When retreat designs are constructed, the shoreline will tend to equilibrate to pre-existing natural slopes after construction. When higher construction templates are built, steeper dune face and backdune slope are maintained because overwash is limited (Grand Isle slopes are steeper when compared with natural slopes of other Louisiana barrier island systems). From analysis of island dimensions and submerged profiles available in the literature (Louisiana Geological Survey - Ritchie et al. 1989, 1990, 1992, 1995; CPE 2000, 2003; List et. al. 1994), design slopes should typically follow these criteria:

- The equilibration of submerged profiles should be anticipated using Dean Equilibrium Profile theory. Closure depths should be defined according to the discussions presented in the Restoration Tools and Best Management Practices chapters.
- Design slope of 1:30 to 1:40 are appropriate for the equilibration of the beachface.
- Appropriate dune design slopes include: 1:45 to 1:55 front and 1:80 to 1:120 for backdune on low islands 1:30 to 1:45 front and back on higher islands
- Marsh slopes in the 1:200 to 1:300 range (relatively flat) reflect best management practices for marsh construction.

Sand sources are available in ebb- and flood tidal shoals, relict deposits on the inner self, in random deposits near the islands, and further offshore in a number of areas (e.g. Ship Shoal and Sabine Banks). Offshore deposits contain larger quantities of sand, but utilizing this sand is more expensive. Prior to selection of final borrow locations, possible impacts to the surrounding areas, including affects on existing wave and current patterns and longshore sediment transport mechanisms, should be fully investigated. Consideration should thus be given to the use of nearby inexpensive sand for the initial restoration of the islands when larger quantities are needed. Maintenance projects (e.g. renourishments) require less volume over longer intervals (Dean 2002). Therefore, subsequent maintenance projects should consider using either nearshore sources (possibly mixed sediments) when large volumes are required or distant sand sources when less material is needed. This strategy is similar to nourishment programs on several Florida Gulf coast projects (Panama City and Captiva Island) where less expensive local sands are used for the initial, larger, beach nourishment projects, and where distant (and more expensive) sands are slated for future maintenance projects.

Regional strategies should also consider the capability of dredging fleets and various types of dredges. For example, in some cases a combination of dredges (pipeline and hopper) can be used to build a beach more effectively. Shallow waters adjacent to barrier islands may require construction of access channels to facilitate efficient composite dredging.

Regional sediment management should be considered within the purview of long-term maintenance objectives so that renourishment programs for the entire barrier shoreline system can be sustained.

In this section, volume density terminologies are defined as follows:

- Advanced Fill Volumes. Advanced fill volumes correspond to the maintenance volumes or the volume density necessary to maintain island configuration for the project lifetime (e.g. 10 years, as applied here). Maintenance volumes were obtained based on historic (long-term) differential retreat rates of Gulf and backbay shorelines by applying the formulas presented in the Best Management Practices chapter.
- Initial Construction, Retreat Design Initial construction retreat design corresponds to the volume density needed to restore uniform island elevation for initial minimal cross-sections (natural slopes and elevations ranging from 5 to 6 ft).

- o <u>Initial Construction, Stabilized Design</u> Initial construction stabilized design corresponds to the volume needed for uniform island restoration. Initial cross-sections will contain higher dunes (8-12 ft) with steeper front and back design slopes.

Site-specific strategies, volumetric estimates, and costs are discussed in the following sections.

10.3 Subprovince 1, Chandeleur Islands

10.3.1 Geographical Location

The Chandeleur barrier island system lies about 25 miles from the mainland and about 75 miles east of New Orleans (See Chap 2, Segments 29-31). The Chandeleur Islands are divided into two main groups: the South Chandeleurs and the North Chandeleurs. The South Chandeleurs are divided into three groups of small islands (Breton Island, Grand Gosier Island, and Curlew Islands; Figure D.10-2). Tidal inlets currently separating these southern islands include, from north to south Pass Curlew, Grand Gosier Pass, and Breton Island Pass. The Mississippi River Gulf Outlet (MRGO Channel) cuts through Breton Island Pass (Figure D.10-2). The North Chandeleur islands are dominated by a relatively large, arcuate shaped, low-lying barrier island that is backed by a group of smaller islands: Freemason Islands, North Islands, and New Harbor Islands. The North Chandeleur Islands are constantly overwashed during storms (Figure D.10-3).

10.3.2 Geological/ Geomorphological Setting

The Chandeleur Islands mark the approximate seaward geologic boundary of the former St. Bernard Delta Complex (Penland et al. 1985). This paleo-deltaic lobe was active from 4,600 to about 1,800 years ago. As described by Ritchie et al. (1992), the islands are the visible portions of an extensive subaqueous sand body that is almost 12 miles (20 km) wide and 16 ft thick (8 m). The islands, which constitute one of the largest barrier island systems along the Mississippi River Deltaic Plain, are low-lying and frequently overwashed during storms (see Figure D.10-3).

Because of the relatively large waves generated in the bay, the mainland coast of St. Bernard Parish exhibits similar geomorphic features to other open coasts, including some well developed barred beaches.

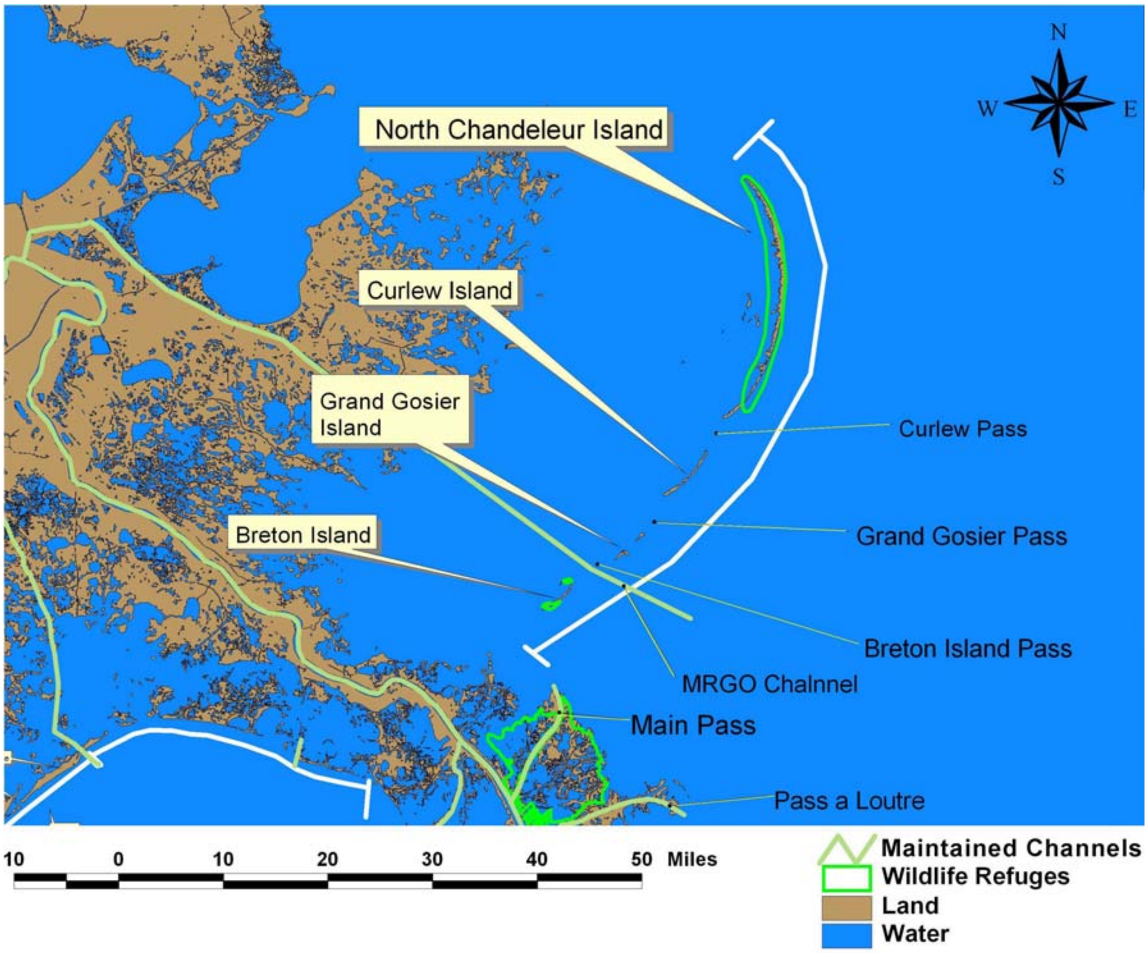

Figure D.10-2. Geographical location of the Chandeleur Islands and passes.

Figure D.10-3. The Chandeleur Islands hours after hurricane Georges on Sept. 29, 1998. Hurricane Georges was only a category 2 hurricane, but the eye of the storm passed almost directly over the chain, causing major overwash and triggering island retreat.

10.3.3 Historical Information (Retreat Rates, Inlet Openings, Human Use)

The Chandeleur Islands derive their name from the catholic candle Mass that was said on the islands several hundred years ago, when the island was inhabited (Penland et al. 1992). Recent deterioration and abandonment of the island systems several miles offshore have, however, prohibited human occupation.

Recent and historical Gulfside and bayside shoreline retreat rates (ft/yr) and area change rates (acres/yr) for the Chandeleur Islands are shown in Table D.10-1.

As interpreted from Table D.10-1, the South Chandeleur Islands maintained their area through time because Gulfside shoreline retreat rates are about the same order of magnitude as bayside progradation rates (Table D.10-1). The area gained during the 1970s and 1980s (short-term record) may be related to the dredging of the MRGO Channel in 1968. Recent analysis of shoreline change between 1988 to 2002 indicates that Gulfside retreat rates increased on Breton Island, reversed on Grand Gosier and Curlew Islands, and increased significantly on the North Chandeleur Islands compared to the long-term record (see Table D.10-1).

The number of inlets and mean dimensions have remained relatively stable since the 1950s, when the current island configuration was achieved. Table D.10-2 shows inlet minimal cross-sections (in miles) for Breton Island Pass and Grand Gosier Pass from 1951 to 1989.

Table D.10-1. Recent and historical shoreline change (ft/yr) and area change (acres/yr) data for the Chandeleur Islands. Data extracted from Williams et al. (1992) (long-term and short-term data sets) and Penland (in press) (recent data set).

Islands	Gulf shoreline (ft/yr)	Bay shoreline (ft/yr)	Area (acres/yr)
	Long-Term Change Rates (more than 100 years of data)		
Breton	-13.5	12.8	-3.46
Grand Gosier	N/A	N/A	N/A
Curlew	-78.4	49.2	-3.71
South Chandeleur Summary	-38.1	35.1	7.17
North Chandeleur	-21.3	9.5	-18.78
	Short-Term Change Rates (1970's to 1988)		
Breton	-13.5	-3.9	5.44
Grand Gosier	N/A	N/A	N/A
Curlew	-78.4	87.9	27.43
South Chandeleur Summary	-64.6	65.0	32.86
North Chandeleur	-40.0	17.4	-11.12
	Recent Gulf Shoreline Change Rates (1989-2002)		
Breton	-63.6	N/A	N/A
Grand Gosier and Curlew	48.0	N/A	N/A
South Chandeleur Summary	-7.8	N/A	N/A
North Chandeleur	-45.7	N/A	N/A

Table D.10-2. Inlet widths for Breton Island Pass and Grand Gosier Pass.

Year	Breton Island Pass Width (miles)	Grand Gosier Pass (miles)
1951	4.2	4.68
1978	2.12	5.44
1989	4.16	4.32

10.3.4 Human Use and Infrastructures

There is no infrastructure on the Chandeleur Islands, except for a navigation lighthouse (see Figure D.10-3). Because the North Chandeleurs and parts of Breton Island (Figure D.10-1) are National Wildlife Refuges, activities that introduce infrastructure or impact the environment are not permitted.

10.3.5 Special and Unique Aspects of the Chandeleur Islands

The Chandeleur Islands are generally similar to other Louisiana barrier islands in terms of geological and geomorphological characteristics. However, they do have some unique features including:

- a large and deep backbarrier bay (12 ft in some sections)
- subaqueous sand below the islands and large sand flats behind the islands that are about three times the size (width) of the modern islands
- pronounced water exchange with neighboring islands via the deep channel cut across Breton Pass (MRGO Channel) and a large opening in its northern extremity
- generally lower area loss rates than other Louisiana barrier islands.

Two hypotheses could account for the lower area loss rates in the Chandeleur Islands.

1. Enhanced tidal flow efficiency created by the MRGO Channel, the large opening to the north, and deep backbarrier bay waters. This flow may decrease pressure on the existing islands, thereby limiting the development of minor breaches to major passes.
2. The re-working of sandy sediments in backbarrier sand flats to the active littoral system as occurs during landward migration.

Scientific investigations of the validity of these hypotheses are beyond the scope of this report. These investigations, if pursued in subsequent studies, may help to optimize restoration strategies for other Louisiana barrier islands.

10.3.6 Island Dimensions

The mean dimensions (e.g. slopes and elevations) of the Chandeleur Islands were directly measured and analyzed from cross-sectional profiles presented by Ritchie et al. (1992). Minimum average dimensions for the Chandeleur Islands (as of 1987 to 1989) are shown in Figure D.10-4. (Note: Figure D.10-4 has a 50 times vertical exaggeration; a 1:200 slope in the natural environment will appear totally flat to the observer eyes). In order to approximate offshore slopes, equilibrium profiles were used.

The dimensions presented in Figure D.10-4 correspond to a subaerial volumetric density of about 80 cy per linear ft (50 m3/m), where less than half of this value (or more) is composed of backbarrier sediments (e.g. mixtures of silts, clays, and sands). The Chandeleur Islands appear to have sandier marsh environments than other Louisiana barrier systems (Penland 2003, personal communication).

Several overwash channels are present, and the island is breached and overwashed frequently (Figure D.10-3). For a detailed description of the geomorphology of the South and North Chandeleur Islands, see the Louisiana Geologic Survey publication “Coastal Sand Dunes of Louisiana: the Chandeleur Island System” (Ritchie, Westphal, McBride, and Penland 1992.).

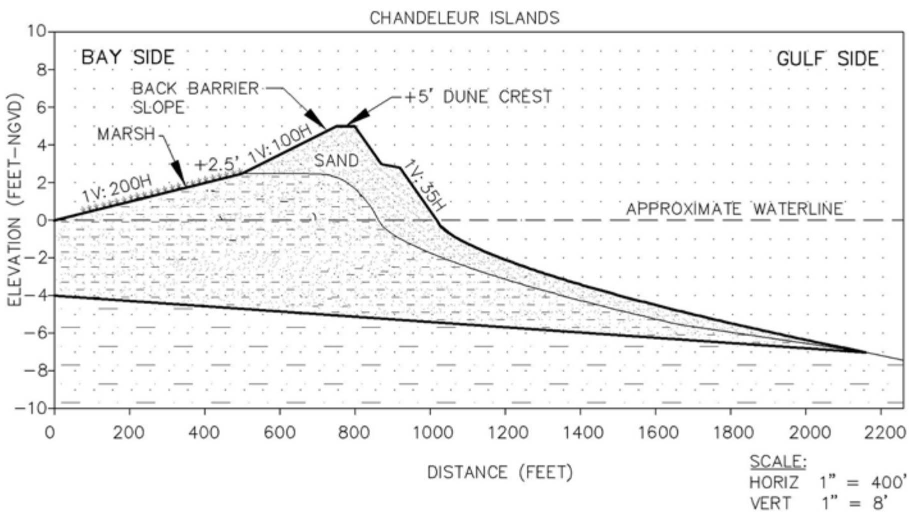

Figure D.10-4. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Chandeleur Islands. Measurements originated from the cross-sections presented by Ritchie et al. (1992). The Figure D.10-is vertically exaggerated 50 times for display purposes.

10.3.7 Identification of Best Strategies for the Area

Because of their unique physical aspects and relative isolation, the Chandeleur Islands are an ideal laboratory for studying natural barrier island processes. Lessons learned from understanding the Chandeleur system can be applied to the restoration of other Louisiana barrier islands. The islands should be monitored for morphological change (emerged and submerged sections), sedimentology and stratigraphy (cores and surface samples), and sources and sinks of sediments. A regional sediment budget should be developed. Proposed strategies for the Chandeleur Islands are presented in Figure D.10-5.

The South Chandeleur Islands are recommended for restoration when sediment is available from navigation dredging projects (i.e. MRGO Channel and Mississippi River main channel). The North Chandeleur Islands are a national wilderness preserve area, which limits the feasibility of repair and renourishment efforts (as previously discussed in the Coast 2050 plan). Emergency restoration efforts to improve island recovery from severe storms may, however, be appropriate. Coordination with the MRGO study task force is also recommended.

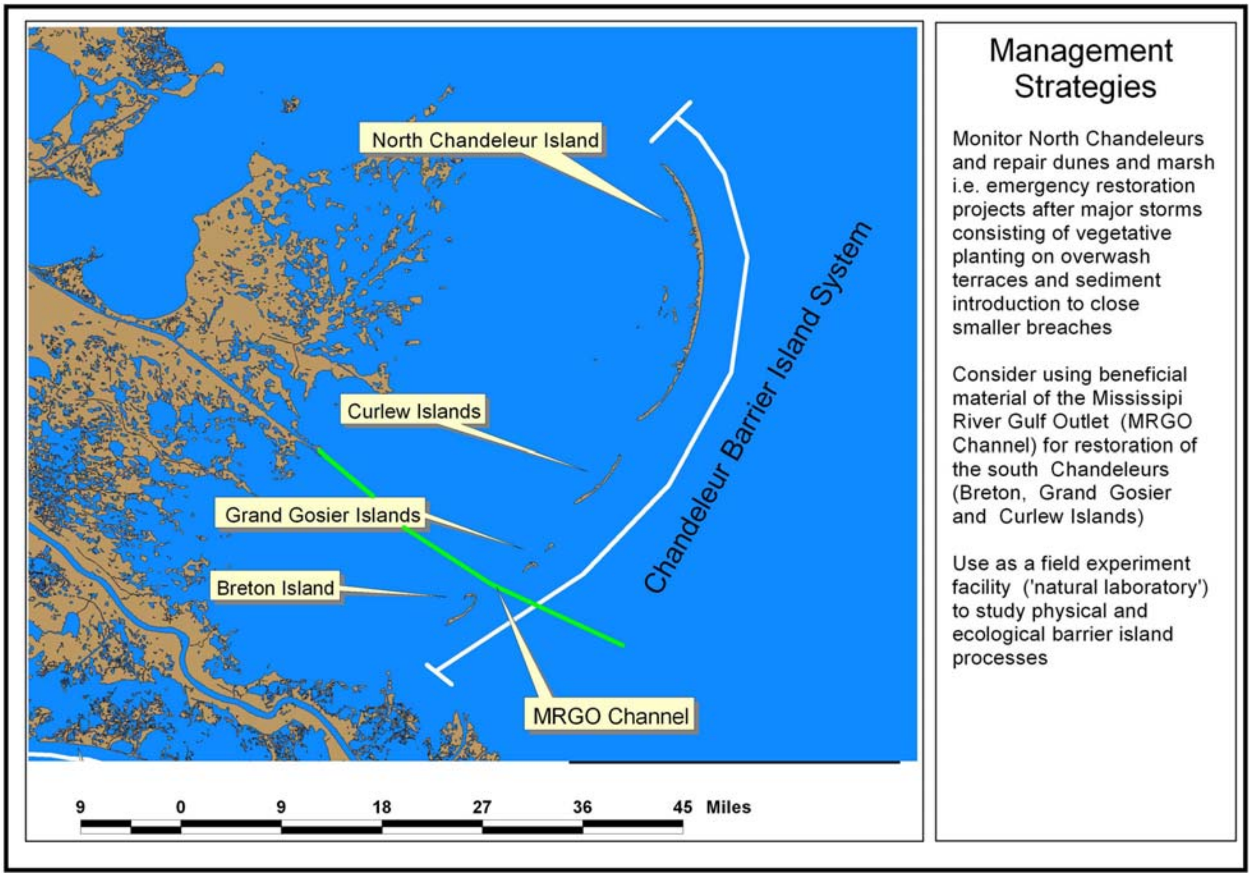

Figure D.10-5. Strategies proposed for the Chandeleur Islands.

10.3.8 Approximate Volumetric Requirements

In order to demonstrate the magnitude of sediment volumes required to restore and maintain the minimum templates for the Chandeleur Islands, volumetric density requirements were calculated based on historical Gulf and bay shoreline behavior. The values are presented in Table D.10-3.

Because immediate restoration of the Chandeleurs is not anticipated here, these volumetric requirements represent only a reference for future endeavors.

As Table D.10-3 indicates, the South Chandeleur Islands are conserving area while retreating. If the islands' position are stabilized, they will require enough volume to offset sea-level rise. As a result, the volume required to maintain a stabilized island will be larger than the volume required to maintain a migrating island (retreat design). Therefore, a retreat design is the most suitable option for the South Chandeleurs, if they are considered for restoration. In the North Chandeleur Islands, by contrast, the maintenance needs for a stabilized design are almost the same as the needs for a retreat design. Maintenance volumes are less if predominantly sandy material (e.g. less than 30% silt and clay) is used for restoration of Gulf and bay areas.

Table D.10-3. Approximate volumetric densities requirements (in cy/ft) to maintain the Chandeleur Islands at the current configuration (maintenance) and to enhance the islands to some uniform minimal cross-section (retreat and stabilized designs)

Island	Design Type*	Design Fill*	Advanced fill (10 yr project)*	Initial Construction (10 yr project)*
South Chandeleurs	Retreat Design	50	20	70
South Chandeleurs	Stabilized Design	150	27	177
North Chandeleur	Retreat Design	50	37	87
North Chandeleur	Stabilized Design	150	32	183

10.3.9 Potential Sand Sources for the Area

Potential sand sources for restoration of the Chandeleur Islands include beneficial material from the MRGO Channel and the Mississippi River's main pass. Coordination with the U.S. Army Corps of Engineers (New Orleans District) should be sought if use of channel maintenance sediments is desired. Additional sand deposits are located near the islands. These deposits are part of the same large sand body on which the islands are anchored. A detailed geotechnical/geophysical investigation could determine whether these deposits would be useful for restoration projects.

10.3.10 Research and Monitoring Needs and Further Plan Development

Monitoring needs include surveys of the entire active beach profiles, continuing subaerial morphological LIDAR surveys, shelf sedimentology and stratigraphy, vegetation cover, sedimentary sources and sinks and development of regional sediment budget, extreme storm impacts on submerged and subaerial island morphology, and development of an island-specific conceptual model that is able to predict future performance of the island based on current regulating process and sources/sinks of sediments.

10.4 Subprovince 2, Plaquemines Shoreline

10.4.1 Geographical Location

The Plaquemines barrier shoreline, which is about 30 miles (48 km) long, extends in a general southwesterly direction from Sandy Point to West Grand Terre Island (See Chapter 2, segments 24-28). This section of the Louisiana coast is located about 25 miles (40 km) west of the modern Mississippi River delta and about 50 miles south-southeast of New Orleans (Figure

D.10-6). Barrier islands that make up the Plaquemines shoreline include (from SE to NW), Sandy Point, Pelican Island, Shell Island, Chaland Headland (Pass de la Mer area), Cheniere Ronquille, and the Grand Terre Islands (Figure D.10-6). Several bayous and passes segment the shoreline (viz. Pass Abel, Quatre Bayoux, Pass Ronquille, Pas de la Mer, Chaland Pass, Fontanelle Pass).

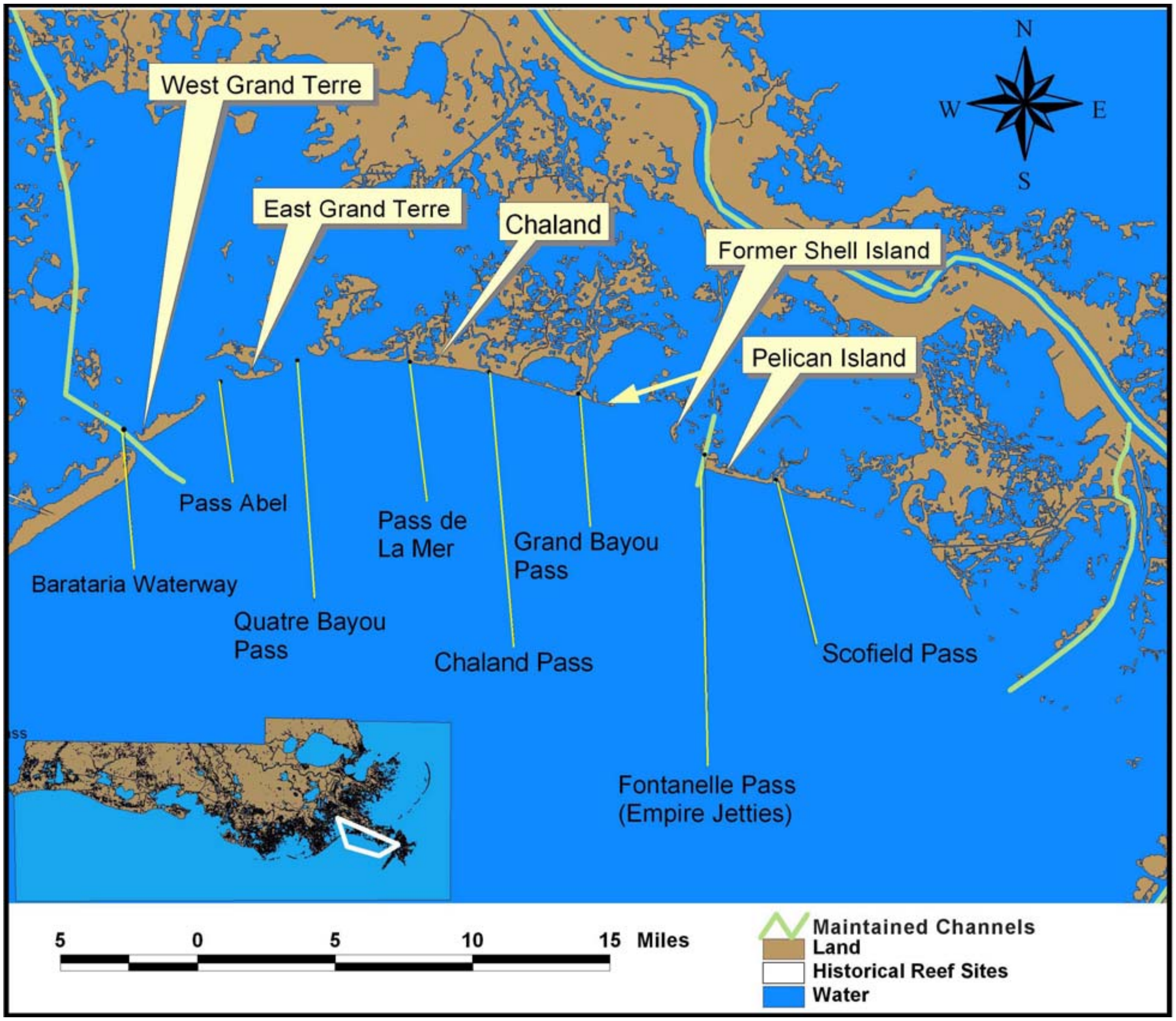

Figure D.10-6. Geographical location of the Plaquemines barrier islands and inlets/passes.

The Plaquemines barrier shoreline has a complicated geological framework because it is associated with different phases of deltaic evolution during the Holocene. Ritchie et al. (1990) indicate that the western margins of the islands lie within the old Lafourche delta lobe, which was active until about 300 YBP. The central area lies within the St. Bernard delta complex, which was active from 1600 to 1800 YBP. The central and eastern coastal segments (most of the Plaquemines shoreline) are associated with the Plaquemines delta lobe, a modern Mississippi River outlet, abandoned about two centuries ago.

During the past century, the Plaquemines barrier shoreline showed significant landward movement, and the islands were reduced in size. Many barrier islands along this coastal reach are now reduced to fragmented relics of formerly robust barrier islands. In many cases, the severely eroded and narrowed beach-dune system is breached in low spots where dune elevations are lowered. The low and narrow beach-dune system now provides little protection from overwash and storm impacts on marsh areas (see Figure D.10-7).

Figure D.10-7. Low-lying fragmented barrier island backed by man-made canals in the central Plaquemines shore, between Pass de la Mer and Chaland Pass.

10.4.2 Unique Aspects

Some unique aspects of the Plaquemines barrier shoreline include:

- the presence of a national historic site at Fort Livingston that requires protection
- rapid area increase of Barataria Bay and related impacts of growing tidal prisms on adjacent islands
- the proximity of a deep-draft maintenance channel at the Barataria Waterway
- complicated geology due to the interaction of three delta lobes
- rapid deterioration (erosion) of Shell island, downdrift of the Empire Jetties.

10.4.3 Island Dimensions

The Plaquemines barrier shoreline is relatively short in length, has low elevations, and is backed by marshlands criss-crossed by pipeline canals and bays (Bay Joe Wise, Bay la Mer, and Barataria Bay). Data cross-sections presented by Ritchie et al. (1990), were used to determine natural slopes and elevations of the following Plaquemines barrier shoreline segments: Bay Joe Wise, Grand Terre, and Pelican Island. The barrier shoreline contains three primary dimensional (morphological) compartments: (1.) a Gulfside slope (dune crest to beachface to shoreface), (2.)

a backbarrier slope (dune crest to back dune face to marsh), and (3.) backbarrier marsh (emergent marshland). Average island dimensions and compartmentalization are summarized in Figure D.10-8.

The dimensions shown in Figure D.10-8 for the subaerial portion of the island are equivalent to a volumetric density of about 74 cy per linear ft; about half of this volume is composed of backbarrier sediments (e.g. mixtures of sands, silts, and clays). Recent surveys of Chaland and Pelican Islands by CPE (2003) indicate that most coastal segments are lower than 5 ft in elevation (NAVD). The historic conditions illustrated in Figure D.10-8 do not mimic current island conditions, and most coastal segments lack minimal cross-sections.

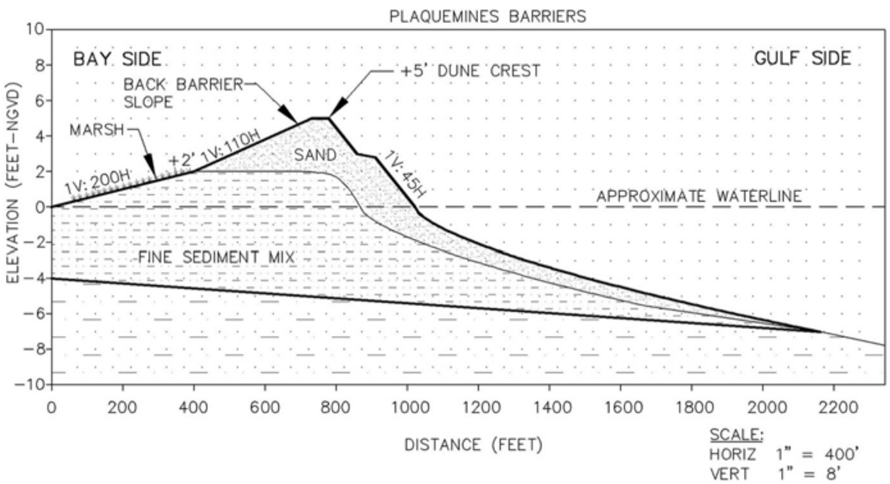

Figure D.10-8. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Plaquemines Islands. Measurements originated from the cross-sections presented by Ritchie et al. (1990). The Figure D.10-is vertically exaggerated 50 times for display purposes.

10.4.4 Retreat Rates, Inlet Openings and Back Bay Areas

The Plaquemines barrier shoreline was so severely eroded in the past century that according to Williams et al. (1992), it is approaching complete disintegration. Localized accretional areas are associated with spit growth (e.g. west flanks of Grand Terre and Shell Island, and updrift from the Empire Jetties), but the overall system is eroding and retreating. Based on 149 cross-shore profiles, Williams et al. (1992) were able to estimate mean shoreline retreat rates for the previous century (Table D.10-4).

The Gulfside long-term record of shoreline changes shows retreat rates on the order of 18 ft/yr (5.5 m/yr). The mean rate of bayside shore progradation, in contrast, is about 1.3 ft/yr (0.4 m/yr). The differential between Gulfside shoreline retreat (retrogradation) and bayside accretion (progradation) resulted in a net narrowing of this barrier shoreline by about 50% over the last century. The mean retreat for the Gulf shoreline has increased through time from 18 ft/yr to about 32 ft/yr (during the 70s and 80s). The most recent data sets (1984 to 2002) show retreat rates of about 42 ft/yr. The accelerating rate of shoreline retreat may be due to the gradual loss of sand from the barrier island system and exposure of the more easily eroded fine sediments (silts and clays of bayside marshes) to the direct attack of Gulf waves.

Minimum cross-sections of Plaquemines inlets, measured from maps used by Williams et al. (1992), are summarized in Table D.10-5. Most major tidal inlets and passes were in existence a century ago, as indicated in Table D.10-5. An exception includes Fontanelle Pass, which opened in the late 1950s and was stabilized in the 1970s by the Empire Jetties. Northwest of the Empire Jetties, the former Shell Island has disintegrated. Now there are several new passes, including Coupe Bob, connecting Shell Island Bay to the Gulf of Mexico. Passes on the mouth of Barataria Bay (Pass Abel, Pass Ronquille, and Quatre Bayou Pass) increased in width from 1932 to 1988 (Table D.10-5). Fitzgerald et al. (2003) hypothesize that increasing pass widths are a function of expanding open water area in Barataria Bay where water surface area increased more than 191,000 acres (775 km2) since 1956 (Fitzgerald et al. 2003). Rates of increasing pass widths are shown in Table D.10-6.

Table D.10-4. Long-term, short-term and recent shoreline change data for the Plaquemines Islands. Data extracted from William et al(1992) (long-term and short term data sets) and Penland (in press) (recent data sets)

Islands	Gulf shoreline (ft/yr)	Bay shoreline (ft/yr)	Area (acres/yr)
	Long-Term Change Rates (more than 100 years of data)		
Plaquemines (mean)	-18.0	1.3	N/A
East/West Grand Terre	-12.8	-7.2	-28.1
Shell Island Reach	-33.1	25.9	-1.4
	Short-Term Change Rates (1970's to 1988)		
Plaquemines (mean)	-32.4	12.1	N/A
East/West Grand Terre	-25.9	-4.0	-26.6
Shell Island Reach	-79.4	67.5	-12.3
	Recent Gulf Shoreline Change Rates (1989-2002)		
Plaquemines (mean)	-42.2	N/A	N/A
West Grand Terre	-21.7	N/A	N/A
East Grand Terre	-50.1	N/A	N/A
Chenier Ronquille	-17.2	N/A	N/A
Shell Island	-101.5	N/A	N/A
Scofield	-20.9	N/A	N/A

Table D.10-5. Historical minimal cross-sections (in ft) of major inlets and passes on the Plaquemines shoreline.

	1884	1932	1956	1973	1988
Barataria Pass	1584	1760	3520	3000	3000
Pass Abel	NA	790	1270	3380	7600
Pass Ronquille	NA	1050	320	1050	2530
Quatre Bayoux Pass	1260	2740	3380	3590	5060
Pass la Mer	1470	1690	210	420	370
Chaland Pass	1470	1450	210	420	260
Grand Bayou Pass	6700	2530	2740	2740	420
Coupe Bob	N/A	N/A	N/A	N/A	5500
Fontanelle Pass	NA	NA	530	490	490
Scofield Pass	630	420	1050	840	1480

10.4.5 Human Uses and Infrastructures

Jetties constructed in the 1970s are located at Pass Fontanelle (the Empire Jetties) and are responsible for downdrift erosion and loss of Shell Island. Several oyster leases are located along backbarrier bays, ponds, and other estuarine environments along the Plaquemines shoreline. Coordination with oyster lease owners is thus necessary for the construction of restoration projects in the Plaquemines coastal segment.

On the western tip of West Grand Terre Island is Fort Livingston, an historical site noted in the National Register of Historical Places. The fort was built in 1841 to defend New Orleans. The protection of Fort Livingston and associated infrastructure on the West Grand Terre Island shoreline stabilization (stabilized design and coastal structures) should be considered for this coastal reach.

Table D.10-6. Rates of increase of tidal inlets that serve as outlets for the Barataria Bay system.

	Rate increase (ft/yr) (1932-1988)	Total % Increase
Barataria Pass	22	170
Pass Abel	121.61	962
Pass Ronquille	26.43	241
Quatre Bayou Pass	41.43	185

10.4.6 Identification of Best Strategies for the Area

In response to the net deterioration of the Plaquemines barrier shoreline, the CWPPRA task force authorized three major restoration projects: East and West Grand Terre Islands, Pass de la Mer to Chaland Pass, and Pelican Island. These projects each contain three components: (1.) nourishment of berm and dune, (2.) backbarrier marsh fill, and (3.) vegetative plantings.

Shoreline stabilization using higher templates and coastal structures are needed on West Grand Terre Island due to the presence of human infrastructure and national historic sites. Other segments of the coast can benefit from the construction of either higher or lower nourishment templates without the aid of coastal structures.

Restoration of other Plaquemines barrier islands should contain the following components:

- a seaward beach berm
- uniform dune systems with elevations ranging from 6 to 10 feet depending on project purposes
- marsh restoration
- vegetative plantings (dunes and marsh
- closure of small breaches and weak (low) spots on the islands
- plugging of selected dredged channels that contribute to the deterioration of back barrier marshes (e.g. Figure D.10-9).

Closure of inlets and passes or reconstruction of islands at former locations should only be considered for the coastal segment located northwest of the Empire Jetties, the only area breached in the last few decades.

Coastal structures should not be considered when retreat designs are built. When a stabilized design is built (higher templates), coastal structures may be considered on a case-specific basis (e.g. bayside marsh protection using permeable revetments, Gulfside terminal groins, or breakwaters). Proposed strategies for remediation and restoration of the Plaquemines barrier shoreline are summarized in Figure D.10-9.

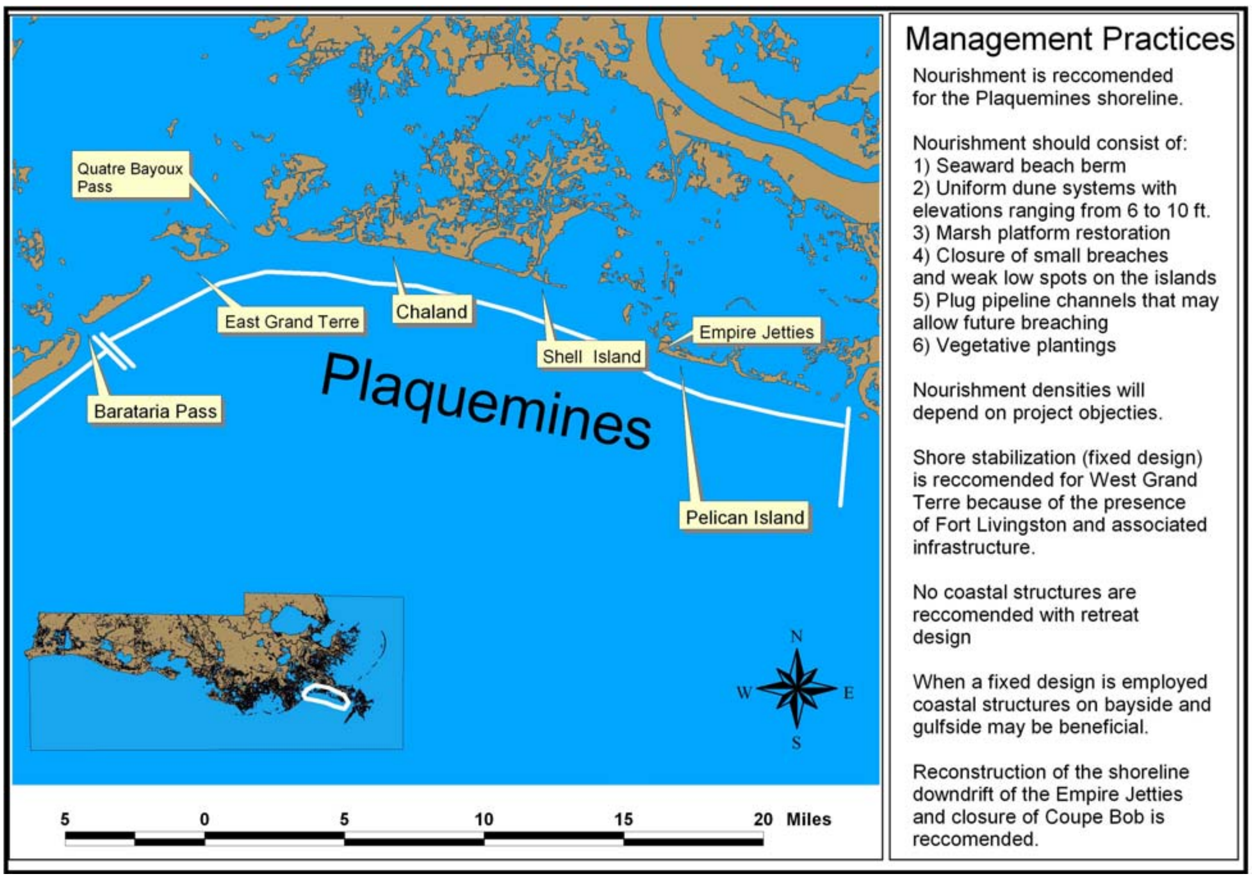

Figure D.10-9. General strategies proposed for the Plaquemines shoreline.

10.4.7 Approximate Volumetric Requirements

In order to demonstrate the magnitude of sediment volumes required to restore and maintain the Plaquemines barrier shoreline, volumetric density requirements were calculated (based on a best management practices approach and historical Gulf and bay shoreline behavior). These requirements were then compared with previous plans for the area. The values are presented in Tables 7 and 8.

Table D.10-7. Approximate volumetric densities requirements (in cy/ft) to restore the Plaquemines barriers to some uniform minimal cross-section (retreat and stabilized designs) and maintain the restored templates (advanced fill)

	Plaquemines shoreline	Plaquemines shoreline
Design Type	Retreat Design (cy/ft)	Stabilized Design (cy/ft)
Design Fill	50.00	150.00
10 yr advanced fill	61.7	39
Initial Construction (10 yr lifetime)	111.7	189

Table D.10-8. Approximate densities proposed for the Plaquemines shoreline by previous restoration plans.

Planned projects	Program	Total fill density proposed (cy/ft)
Pelican Island	CWPPRA	213.00
Chaland	CWPPRA	194.00
Barrier Island Feasibility Study - Alternative 1	COAST 2050	348.78
Barrier Island Feasibility Study - Alternative 2	COAST 2050	139.02

Approximately 40% of the Plaquemines shoreline will be restored under the CWPPRA program (East/West Grand Terre, Chaland, and Pelican Island). The remaining 60% of the Plaquemines barrier shoreline, including Shell Island, needs initial restoration if such activities are anticipated in the next ten years. If renourishment is anticipated after 20 years, the entire Plaquemines barrier shoreline will need initial fill plus advanced fill.

Based on the densities presented in Table D.10-7, it is estimated that, after the initial round of construction is completed, about 800,000 cubic yards per year (8,000,000 in a 10-yr renourishment cycle) will be necessary to maintain the enhanced (restored) templates of the entire Plaquemines barrier shoreline in a retreat design scenario. About 480,000 cy per year (4.8 million in a 10 year cycle) will be necessary in a stabilized design scenario.

Maintenance volumes will be less if predominantly sandy material (e.g. less than 30% silt plus clay) is used for restoration of Gulf and bay areas in the retreat design scenario, or if coastal structures are placed in conjunction with the stabilized design scenario to reduce longshore losses.

10.4.8 Potential Sand Sources for the Area

Sand is a limited resource along the Plaquemines shore. The most promising deposits for this area are the Quatre Bayou and Barataria ebb-tidal shoals and a relatively large overburden channel offshore Sandy Point (Kindinger et al. 2001; CPE 2003b). Finer sediment mixtures for marsh restoration are, however, available near most barrier islands. Beneficial use of sands from maintenance dredging of the modern Mississippi River (e.g. Tiger Pass) may also be considered for restoration of the Plaquemines barrier islands.

10.4.9 Research Monitoring Needs and Further Plan Development

The entire active profile of the constructed projects should be monitored to allow performance assessment and refinement of maintenance volumetric needs. Monitoring of shoreline configuration and barrier island area with remote sensing techniques (e.g. aerial photography, LIDAR, satellite imagery) should also continue. A regional sediment budget that can be refined over time (GIS sediment budget) would also help define future designs and the refinement of volumetric requirements for specific projects.

10.5 Subprovince 2, Lafourche Shoreline (Caminada-Moreau Headland and Grand Isle)

10.5.1 Geographical Location

The Lafourche shoreline, as described in this report, is the coastal stretch between Belle Pass and Barataria Pass (Figure D.10-10).

Caminada-Moreau Headland (Segment 22) and Grand Isle (Segment 23) are located within this segment, which is situated about 55 miles (88 km) south of New Orleans and about 50 miles (80 km) NW of the Mississippi River delta (Figure D.10-10). Grand Isle is located between Caminada Pass to the west and Barataria Pass to the east. The Caminada-Moreau Headland is located between Caminada Pass and the Belle Pass jetties (Figure D.10-10).

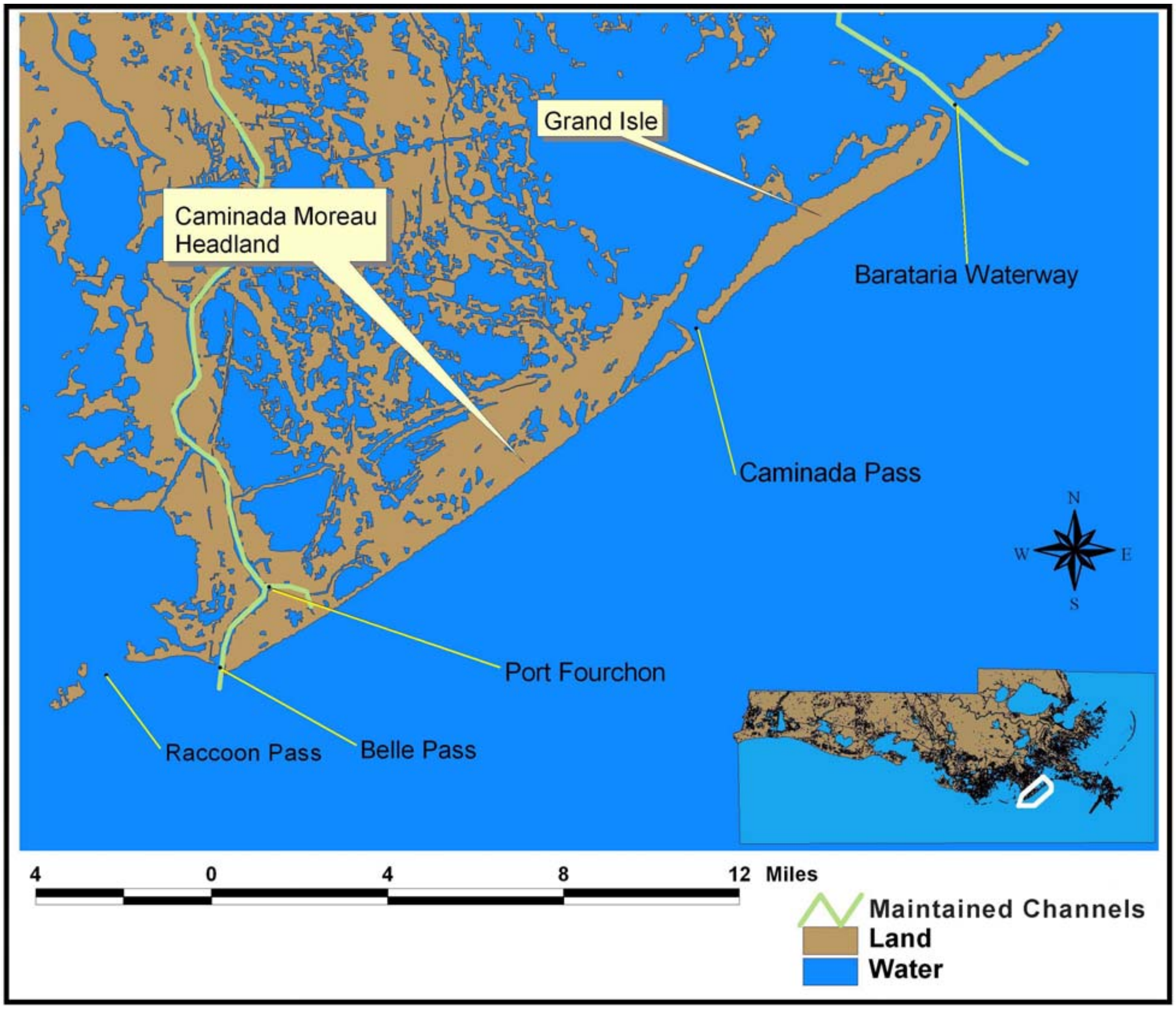

Figure D.10-10. Geographic location of Grand Isle and Caminada-Moreau Headland and associated inlets/passes.

10.5.2 Geological Heritage and General Geomorphology

The Lafourche barrier shoreline is an erosional headlands with flanking barrier islands (e.g. Penland et al. 1988) that resulted from reworking and winnowing of sediments from the former Lafourche delta (abandoned about 2,500 to 800 YBP). Grand Isle, backed by Barataria Bay, is a drumstick shaped barrier island that has a narrow western end and a wide eastern end. The Caminada-Moreau Headland, a barrier coastal segment anchored to the mainland, contains cohesive deltaic sediments, a sandy beach ridge plain, and a spit at the eastern end. Backbarrier lagoons are absent except for the eastern end (spit section) of the headland and the Bay Champagne area. Several pipeline canals and bayous segment the back barrier wetlands.

10.5.3 Retreat Rates, Acreage Loss, and Inlet Openings

Grand Isle is the most stable of the Louisiana barrier islands; from 1887 to 1934 the island's average rate of retreat was 2.9 ft/yr (0.9 m/yr). Since the 1950s, the island's location has been maintained by coastal protection works (e.g. nourishment and coastal structures). Barataria Pass, located on the eastern end of Grand Isle, is the deepest tidal channel in the Barataria Basin (40 feet); it was stabilized by a jetty constructed in the 1950s by the Louisiana Office of Public Works (USACE 1980). Since introduction of the jetties, the island has been eroding on its western end but accreting against the jetty in the east. As a result, the island is slowing rotating clockwise around a relative stable point in the middle (USACE 1980, Williams et al. 1992). The accretion against the east jetty exceeds the amount of erosion in the western end of the island. Caminada-Moreau Headland to the west is believed to be the additional source of sediments.

Figure D.10-11. The coast at the northwestern segment of the Caminada-Moreau Headland showing small salients behind a breakwater field (center of image), a small downdrift erosional feature with small overwashes (top right) and the presence of industrial infrastructure and the Port Fourchon (center and top left) oil and gas production facilities.

The Caminada-Moreau Headland has experienced rapid rates of shoreline retreat (45 ft/yr) over the last century. The retreat rates have been higher on the western end of the island (Williams et al. 1992), which is the section where several industrial and public infrastructures (viz. oil and gas production facilities and Port Fourchon; see Figure D.10-11) are present.

Long-term, short-term, and recent shoreline retreat rates for Grand Isle and Caminada-Moreau Headland are presented in Table D.10-9. The recent rates (1985 to 2002) indicate that retreat at Grand Isle has accelerated significantly (Table D.10-9). The present barrier islands and inlet configuration on the Lafourche coast was already stabilized during the last century (Table D.10-10).

Belle Pass and Barataria Pass have been stabilized by the introduction of rock jetties (on both sides at Belle Pass and at the western margin at Barataria Waterway). Caminada Pass has remained relatively stable since the 1950s.

Table D.10-9. Long-term, short-term and recent shoreline change data for the Lafourche shoreline. Data extracted from Williams et al(1992) (long-term and short term data sets) and Penland (in press) (recent data sets)

Islands	**Gulf shoreline (ft/yr)**	**Bay shoreline (ft/yr)**	**Area (acres/yr)**
	Long-Term Change Rates (about 100 years of data)		
Grand Isle	2.95	-3.28	-3.28
Caminada Moreau	-43.64	13.45	1.00
	Short-Term Change Rates (1970's to 1988)		
Grand Isle	17.06	-10.50	3.61
Caminada Moreau	-44.62	-5.91	N/A
	Recent Gulf Shoreline Change Rates (1989-2002)		
Grand Isle	-14.90	N/A	N/A
Caminada Moreau	-8.60	N/A	N/A

Table D.10-10. Length of inlets/passes (in ft) in the vicinity of Caminada-Moreau Headland and Grand Isle.

	Caminada Moreau Headland	Caminada Moreau Headland
Design Type	Retreat Design (cy/ft)	Stabilized Design (cy/ft)
Design Fill	40	125
10 yr advanced fill	81	50
Initial Construction (10 yr lifetime)	121	175

10.5.4 Current Human Uses and Infrastructures

Grand Isle is the only developed barrier island (commercially and residentially) on the Louisiana coast (Figure D.10-12).

Figure D.10-12. Color infrared image of the eastern end of Grand Isle illustrating island geomorphology (e.g. curved spit) and the presence of private and industrial infrastructure.

Because the island originally had low-elevations (5 ft prior to nourishment), hurricanes caused major structural damage and loss of lives (e.g. 1893 when about 1,000 people were drowned, and Hurricane Betsy in 1965 when most of the structures failed and fatalities were numerous; USACE 1980). Caminada-Moreau also contains public and industrial infrastructure (including roads, public beaches, oil and gas production facilities) and Port Fourchon (see Figure D.10-11).

As a response to constant damage to infrastructure and loss of life, Grand Isle has been maintained by a combination of beach fill and structures since the early 1950s. In 1985, the island was restored to higher elevations (11.5 ft), and the dune has been maintained above 10 ft since then. Since 1954, the Grand Isle nourishment program has maintained the location and volume of the Grand Isle dune and beach system with structure-fill combinations. During the 1985 project, 2.8 million cy were placed along seven miles of Grand Isle, corresponding to a density of 75 cy/ft. Over the long-term, the program has been maintained with volumes ranging from 2 cy/ft/yr to 4 cy/ft/yr (Combe 2003).

Efforts to minimize shoreline retreat at the Caminada-Moreau Headland included a series of 13 semi-submerged barges that were placed on the shoreline by private oil companies. The barges were intended to act as breakwaters and to protect the oil production facilities. The first four structures in this breakwater field resulted in the formation of a relatively small salient on the shore, while the downdrift structures appeared to have had no significant effect (Figure D.10-11). Downdrift erosion is occurring east of the last breakwater where shoreline offset and several overwash fans are noted.

In 1998, a marsh restoration project was performed west of Belle Pass, which included the placement of approximately 1.5 million cy of beneficial dredge material to restore marsh and downdrift beach. No nourishment projects were constructed in the area between Belle Pass and Caminada Pass.

10.5.5 Island Dimensions

Natural morphometric characteristics for the Caminada-Moreau Headland and Grand Isle are shown in Figure D.10-s 13 and 14.

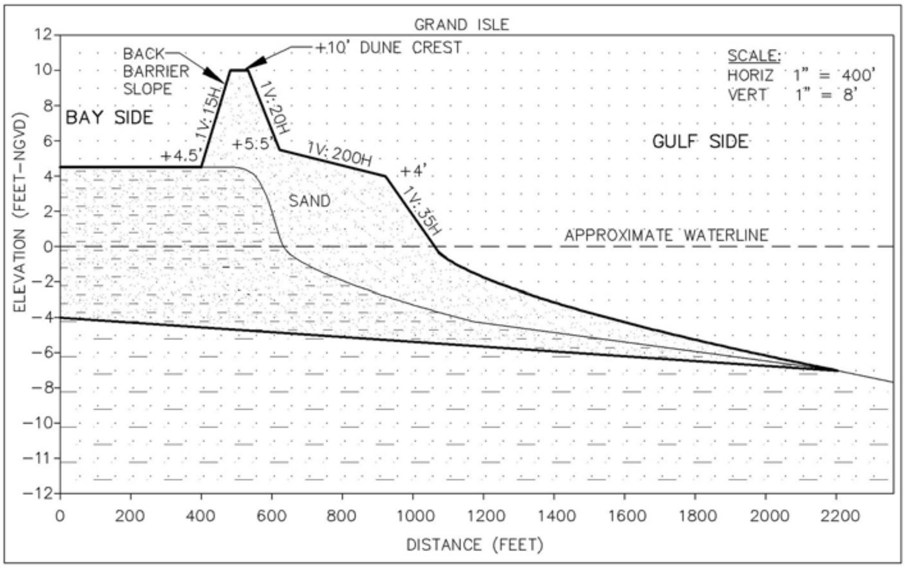

Figure D.10-13. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for Grand Isle. Measurements originated from the cross-sections presented by Ritchie et al. (1995). The Figure D.10-is vertically exaggerated 50 times for display purposes.

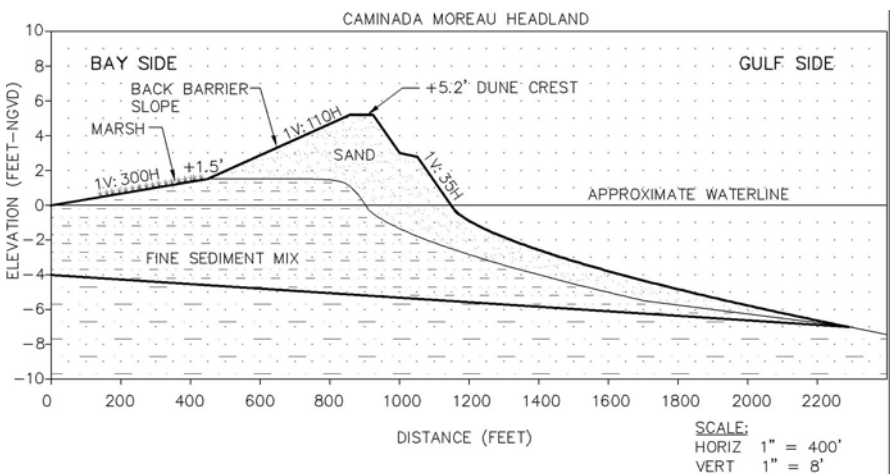

Figure D.10-14. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Caminada-Moreau Headland. Measurements originated from the cross-sections presented by Ritchie et al. (1990). The Figure D.10-is vertically exaggerated 50 times for display purposes.

These dimensions correspond to a volumetric density of approximately 145 cy/ft for Grand Isle and 86 cy/ft for the Caminada-Moreau Headland. Island dimensions presented in Figure D.10-s 13 and 14 will vary from the present island configuration. The slopes presented can provide guidance for future restoration projects.

10.5.6 Identification of Best Strategies for the Area

Recent retreat data (Table D.10-9) indicate that the island will require renourishment soon. Funding to perform physical monitoring of submerged and subaerial sections of the island needs to be secured. The monitoring data should be used to analyze the performance of nourishments and structures, to enhance future project designs, and to identify the most appropriate time to re-nourish the beach.

Grand Isle is one case where the construction of higher templates and combination of beach fill and structures has been completed to better protect the industries, homes, and highways present on the island, Restoration strategies proposed for Grand Isle and Caminada-Moreau Headland are shown in Figure D.10-15.

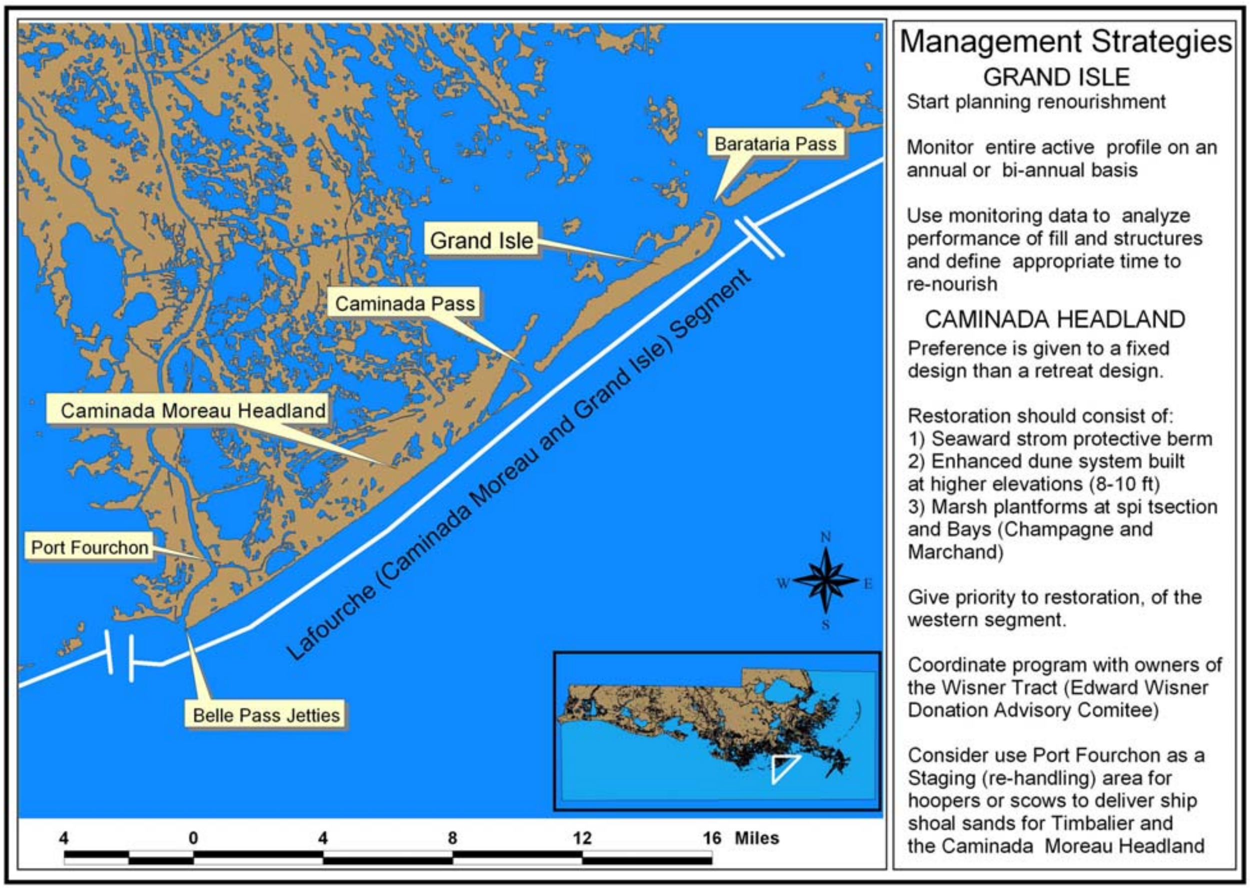

Figure D.10-15. Proposed strategies for the Lafourche shoreline.

Nourishment for the entire Caminada-Moreau Headland is recommended. If no action is taken to prevent retreat of the western end of the Caminada- Moreau Headland, the facilities described above could be threatened in the near future (e.g. next 5 to 20 years). Maintaining the headland shoreline will help avoid future structural damage, loss of life, and damage to the environment during major hurricanes. A higher design template with enough advanced fill is recommended for the headland area. Caminada-Moreau Headland fill placed east of the Belle Pass jetties will act as a feeder beach to Grand Isle. Fill placed west (downdrift) of the Belle Pass jetties will act as a feeder beach to the Timbalier Islands. The use of coastal structures may be appropriate in some segments of the headland.

Independent of the application of coastal structures, nourishment templates for the Caminada-Moreau Headland should include three main components: (1.) a wider beach berm constructed seaward, (2.) a higher dune composed of relatively clean sands (e.g. 8 to 10 feet height), and (3.) a back barrier marsh/slope composed of fine sand or mixed sediments in segments where the Gulf shoreline is backed by open water or is severely fragmented (e.g. Bay champagne, Bay March and, Caminada Spit and vicinities). The construction templates will not be the same for the whole extent of the headland (about 14 miles), but will vary depending on the presence of infrastructure and coastal structures, the historical behavior of each segment, the presence/absence of backbays, and current configurations. Greater densities will be necessary for the western end of the island due to the presence of infrastructure and greater retreat rates.

Local sand sources from adjacent ebb-tidal shoals (e.g. Caminada Pass and Barataria Pass) and beneficial use of dredged material from Port Fourchon may provide some local sediment sources for the headland. However, for the long-term maintenance of this system, we recommend the use of Port Fourchon as a staging (re-handling) area for the delivery of Ship Shoal sands for Timbalier and the Caminada- Moreau Headland.

10.5.7 Approximate Volumetric Requirements

Approximate volumetric density requirements were calculated (based on a best management practices approach and historical Gulf and bay shoreline behavior) for the Caminada- Moreau Headland. The values are presented in Table D.10-11.

Table D.10-11. Approximate volumetric densities requirements (in cy/ft) to restore the Caminada-Moreau Headland to some uniform minimal cross-section (retreat and stabilized designs) and maintain the restored templates (advanced fill)

	Caminada Moreau Headland	Caminada Moreau Headland
Design Type	Retreat Design (cy/ft)	Stabilized Design (cy/ft)
Design Fill	40	125
10 yr advanced fill	81	50
Initial Construction (10 yr lifetime)	121	175

Based on the densities presented in Table D.10-11, it is estimated that, after the initial round of construction is completed (retreat design), about 570,000 cy/yr (5.7 million in a 10-year renourishment cycle) will be necessary to maintain the enhanced (restored) templates of the entire Caminada-Moreau headland shoreline. About 350,000 cy/yr (3.5 million in a 10-year renourishment cycle) will be necessary to maintain the islands if initial higher densities of predominantly sand sediments (stabilized design) are placed on the headland. Maintenance volumes will be less if predominantly sandy material (e.g. less than 30% silt and clay) is used for restoration in the retreat design scenario, or if structures are used to reduce longshore losses in the stabilized design scenario.

10.5.8 Research and Monitoring Needs

The relative accessibility of the Caminada Headland facilitates detailed annual or bi-annual surveys of the entire active profiles. This information can promote significant future cost savings. Monitoring data will be used to refine initial maintenance volumetric requirements, since the headland's behavior after the first large-scale restoration may differ significantly from its historical behavior. Monitoring of shoreline configuration and barrier island area should be conducted with remote sensing techniques (e.g. aerial photography, LIDAR, satellite imagery). A regional sediment budget that can be refined over time (GIS sediment budget), and a conceptual model describing predominant processes and sources/sinks of sediments in the headland should also be developed using the monitoring data.

10.6 Subprovince 3, Timbalier Islands

10.6.1 Geographical Location

Timbalier and East Timbalier islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles SW of New Orleans, Louisiana. The islands are backed by Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass the west (Figure D.10-16).

The islands are about 0.1 to 0.6 mile wide, with low elevations (e.g. mean dune height before construction of recent CWPPRA projects was about 5 ft). Both islands are backed by several man-made canals. Oil and gas production facilities are prevalent in the East Timbalier Islands, while only a few scattered facilities are present along Timbalier Island (Figure D.10-17).

10.6.2 Geological Heritage and General Geomorphology

The Timbalier Islands are flanking barrier islands bordering Timbalier Bay located in the western edge of the Bayou Lafourche barrier system (associated with the former Lafourche delta abandoned about 2,500 to 800 YBP). As described by Penland et al. (1992), flanking barrier islands are typically formed through a series of processes that includes re-curved spit building and extension. Subsequent storm-hurricane impacts can also lead to breaching and island formation.

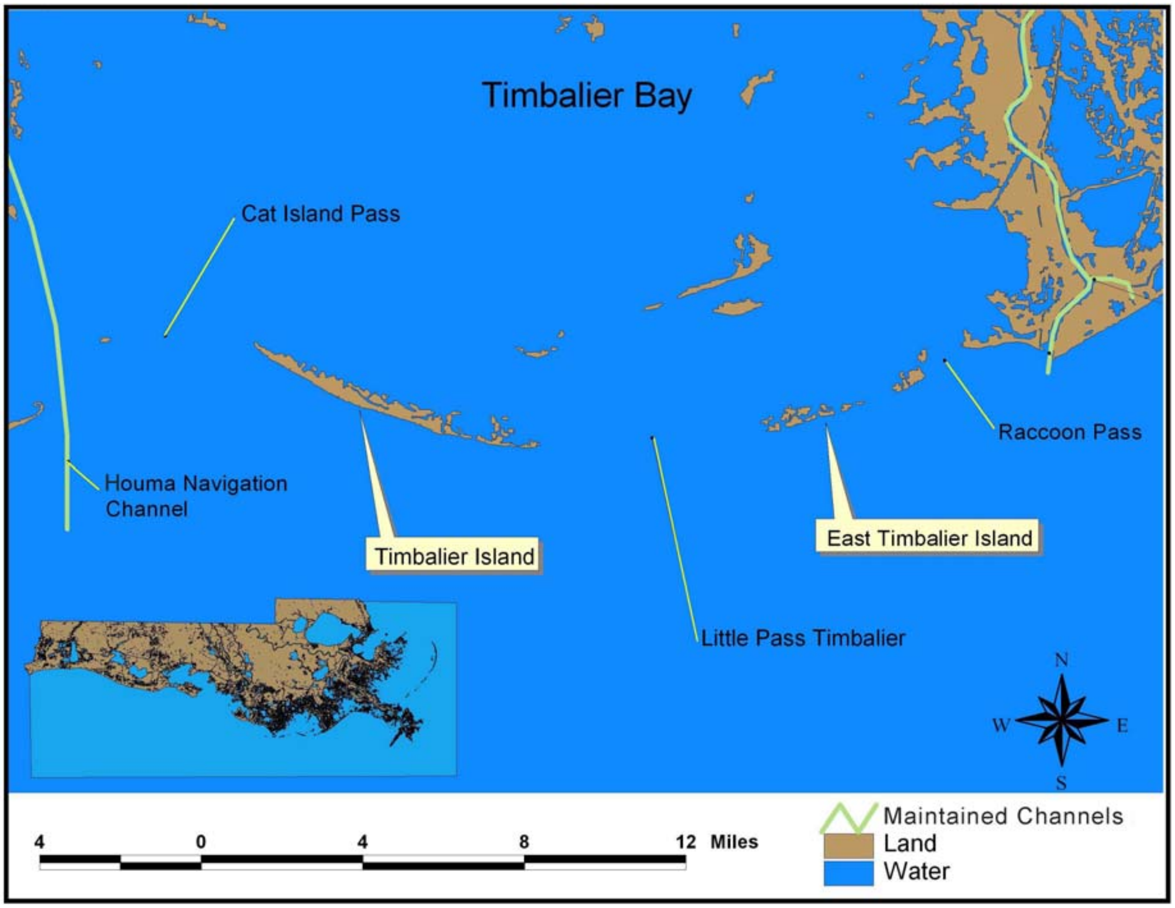

Figure D.10-16. Geographic location of Timbalier Islands and associated passes.

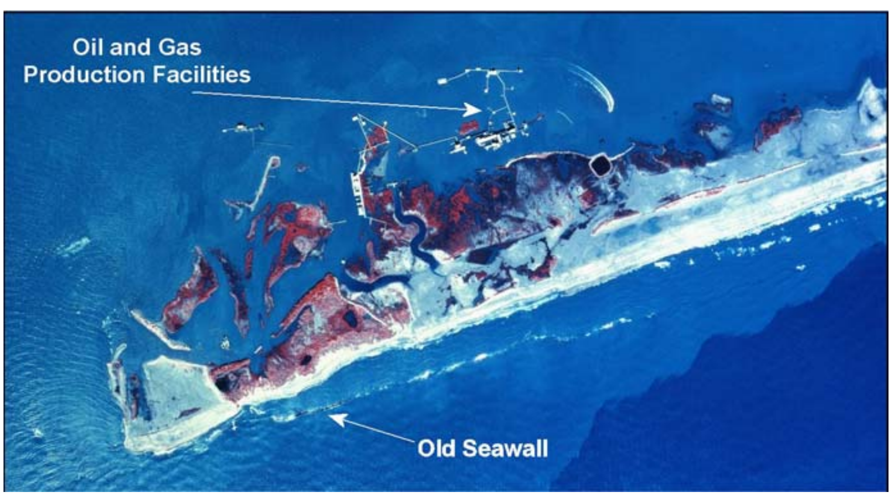

Figure D.10-17. Color infrared images of East Timbalier Island illustrating general geomorphology and presence of oil and gas production facilities in the back bay.

10.6.3 a Retreat Rates, Acreage Loss and Inlet Openings

The Timbalier Islands are very dynamic systems that are migrating both landward and laterally. Williams et al. (1992) describes East Timbalier Island as migrating landward in response to overwash, while Timbalier Island migrated both laterally (spit growth) and landward. Over the last century, Timbalier Island lost most of its area, shrinking from 3,580 acres to 1,349 acres (Williams et al. 1992). Most of the loss occurred on the bayside as shown in Table D.10-12. From 1978 to 1988, the island lost an average of 63 acres/yr as result of opposite rates of migration of Gulf and bayside shorelines (the bayside shoreline migrated seaward while the Gulf shoreline migrated landward).

Long-term, short-term, and recent Gulf shoreline and bay shoreline change rates for East Timbalier and Timbalier Island are shown in Table D.10-12.

Table D.10-12. Long-term, short-term and recent shoreline change data for the Timbalier Islands. Data extracted from Williams et al (1992) (long-term and short term data sets) and Penland (in press) (recent data sets)

Islands	Gulf shoreline (ft/yr)	Bay Shoreline (ft/yr)	Area (acres/yr)
	Long-Term Change Rates (about 100 years of data)		
East Timbalier	-42.98	78.74	0.00
Timbalier	-7.87	-16.40	0.99
	Short-Term Change Rates (1970's to 1988)		
East Timbalier	-69.55	-3.94	-63.51
Timbalier	-22.97	-46.26	-112.93
	Recent Gulf Shoreline Change Rates (1989-2002)		
East Timbalier	-36.00	N/A	-25.3
Timbalier	-96.00	N/A	-36.6
Timbalier East segment	-179	N/A	N/A
Timbalier West Segment	-13	N/A	N/A

Gulf shoreline retreat rates have increased significantly on both East Timbalier and Timbalier Islands. However, monitoring data have demonstrated that rates of area change have diminished in recent years (Figure D.10-18).

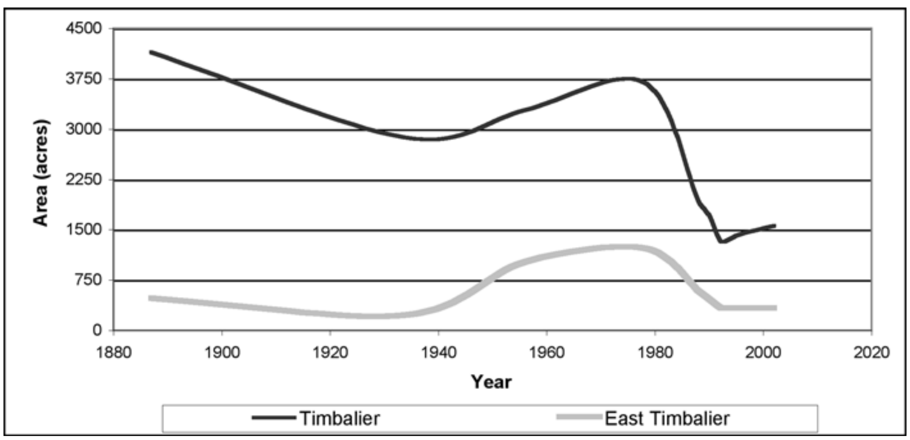

Figure D.10-18. Area change (in acres) for Timbalier and East Timbalier Islands over the last century.

The main inlets near Timbalier and East Timbalier Islands were already present a century ago (Table D.10-13). Historical data presented in Table D.10-12 shows cycles of inlet widening and narrowing from 1887 to 1956. Since the 1950s, however, all inlets associated with the Timbalier Islands have considerably widened (Table D.10-13).

Table D.10-13. Historical dimensions of main inlets/passes associated with Timbalier and East Timbalier Islands.

	1887	1934	1956	1978	1988
Cat Island Pass	13,517	28,512	14,362	14,150	18,480
Little Pass Timbalier	3,379	28,512	12,038	20,416	23,654
Raccoon Pass	2,464	4,500	845	1,267	4,858

10.6.4 Human Uses and Previous Interventions

Several coastal structures were placed in these two islands over the two last decades to protect the land and associated oil and gas infrastructure from direct storm attack. East Timbalier Island, for example, has two lines of seawalls running across it as well as a few T-head groins at its western end (Figure D.10-17). Seawalls are also present on Timbalier Island. Recently, an island wide restoration project was constructed in East Timbalier Island with CWPPRA funds (TE-25 and TE-30) (Picciola and Associates 2000). The project initially increased the area of East Timbalier by about 50%, but because of construction problems, the cost/acre was higher than for other restored barrier islands ($163,370 per acre of land, Penland et al. 2003). Construction problems included modified field conditions, poor sediment quality in the borrow area, and fill containment issues.

Lessons learned from the East Timbalier project include:

- When attempting to close open water breaches, the fill should be contained by dikes or similar containment structures.
- Detailed geotechnical mapping of the borrow area is required before construction.
- A pre-construction survey should be performed immediately before construction, and the designs should be modified to reflect evolving conditions.

10.6.5 Island Dimensions

Mean island dimensions were calculated from the data presented by Ritchie et al. (1995) and are presented in Figure D.10-19.

These dimensions correspond to a subaerial volumetric density of approximately 75 cy/ft. Island dimensions presented in Figure D.10-19 may differ from the present island configuration because of construction and recent erosion. However, the slopes presented can provide guidance for future restoration projects. The island template also provides guidance for selection of the design island profile (minimum natural cross-section).

10.6.6 Identification of Best Strategies for the Area

Beach nourishment is recommended for Timbalier Island. Re-nourishment is recommended for East Timbalier Island when the initial project configuration has eroded. Proposed management strategies for the Timbalier shoreline are summarized in Figure D.10-20.

It is estimated that the fill densities placed on East Timbalier Islands are equivalent to an initial retreat design or advanced fill for about six to eight years. The revetment built in phase with the CWPPRA nourishment has not effectively stabilized the island. We suggest, therefore, that a stabilized island design with 10 years of advanced fill be constructed when the initial project configuration has eroded (2006 to 2008).

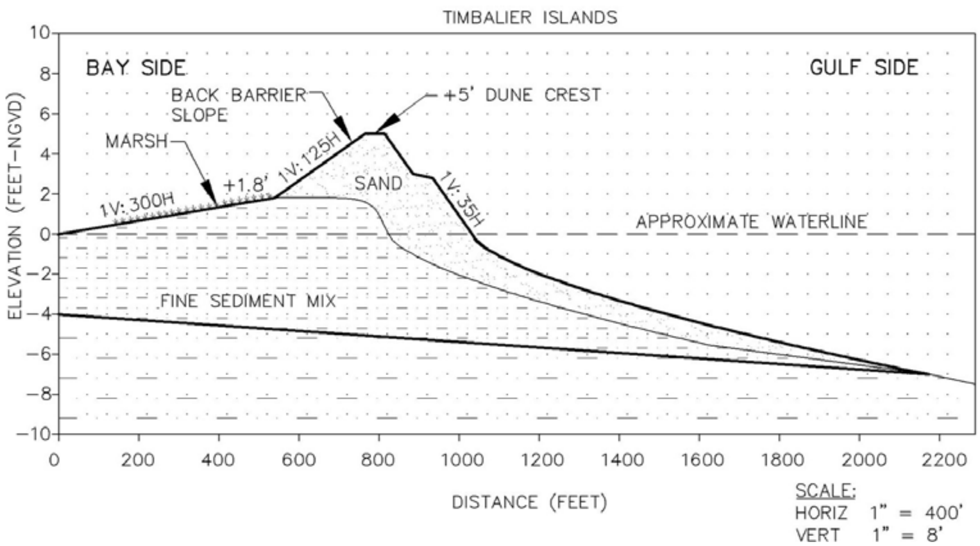

Figure D.10-19. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Timbalier Islands. Measurements originated from the cross-sections presented by Ritchie et al. (1990). The Figure D.10-is vertically exaggerated 50 times for display purposes.

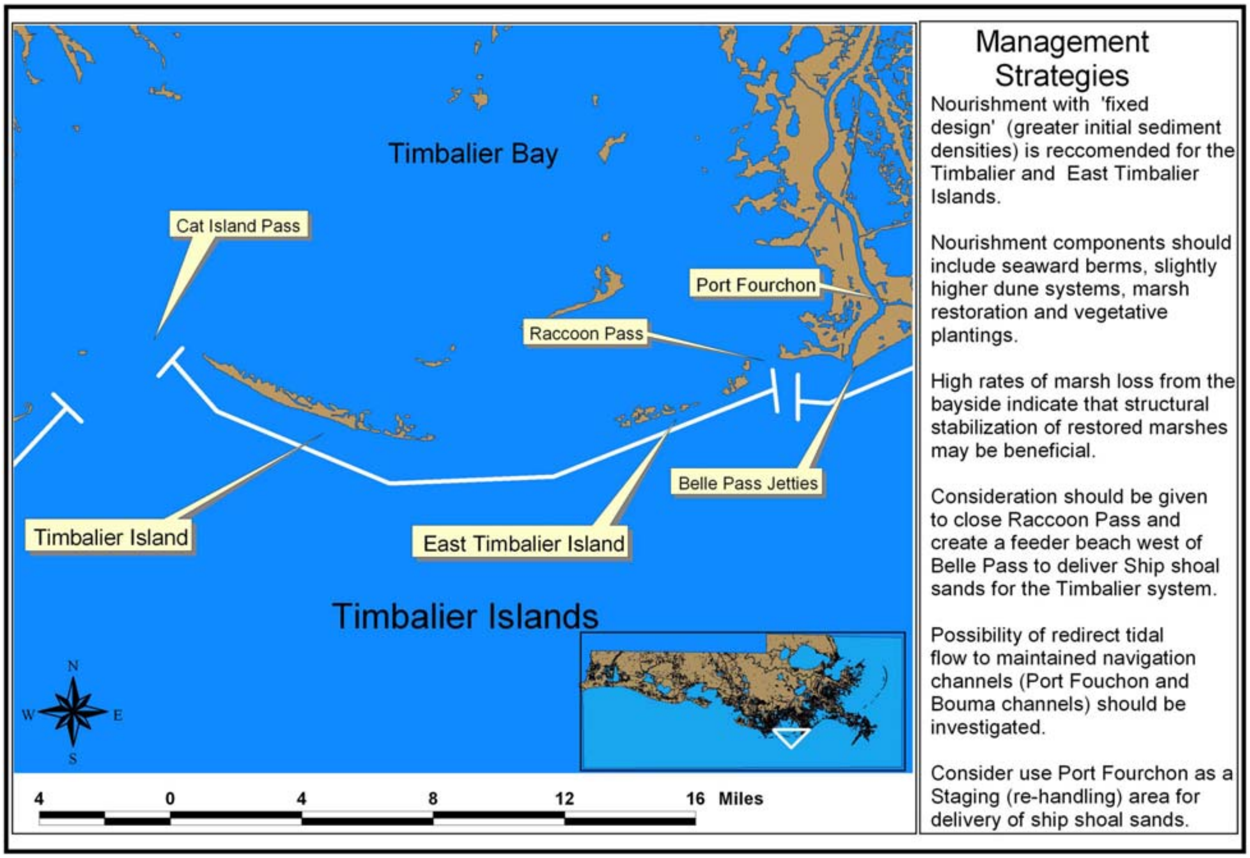

Figure D.10-20. Proposed strategies for East Timbalier and Timbalier Islands.

Restoration on Timbalier and East Timbalier islands should contain the following components:

- a seaward beach berm (storm buffer
- uniform dune systems with elevations ranging from 6 to 10 feet depending on project purposes
- marsh restoration
- vegetative plantings
- closure of small breaches and weak (low) spots on the islands.

Consideration should also be given to closing Raccoon Pass in order to connect the Timbalier Islands with the west flank of the Caminada-Moreau Headland. The closure of Raccoon Pass could re-establish the path of littoral drift from the headland to the Timbalier Islands. The section west of the Belle Pass jetties on the headland would then act as a feeder beach. Closure of Raccoon Pass may require temporary obstructions (for example, sheet piles) in the pass. Hydrodynamic studies and tidal prism management should also be considered. A coastal analysis and economic study would be required to make a decision on Raccoon Pass closure. Ship Shoal sand delivery to the west of Belle Pass jetties could use Port Fourchon could be used as a staging area for delivery of Ship Shoal sands to the west of the Belle Pass jetties.

Preference should be given to stabilized designs (higher denser templates) for East Timbalier and West Timbalier Islands because: (1) oil and gas production facilities are present; (2) high marsh losses from the bayside call for structural stabilization; (3) the possibility of creating a feeder beach south of the Belle Pass jetties (using re-handling of Ship Shoal sands via Port Fourchon).

Structures should generally not be considered when retreat designs (lower templates) are built. When a stabilized design is built, bayside marsh protection by permeable revetments and Gulfside erosion control structures (e.g. terminal groin at Cat Island Pass) may be beneficial. Historical long-term retreat rates show that a large portion of the Timbalier Islands were lost due to erosion on the bayside (Table D.10-12). Therefore, restoration plans should consider providing enough sediment on the bayside marsh for structural protection of these marshes.

10.6.7 Approximate Volumetric Requirements

In this section, advanced fill and design volume densities are presented for East Timbalier and Timbalier Islands.

Initial construction of East Timbalier was accomplished in 2000 by CWPPRA projects TE-25 and TE-30. As-built reports indicate that a total of 2.7 million cy of sediments were dredged from borrow areas located adjacent to the island. Applying a constant cut-to-fill ration of 2:1, we estimate that about 1.35 million cy of sediments were placed on the island (actual cut-to-fill rations fluctuated from 1.5:1 to 5:1). This corresponds to a density of about 55 cy/ft of mixed sediments placed, which is roughly equivalent to an initial (retreat) design volume, or about six to eight years of advanced fill. Based on historical island behavior, volumetric needs for East Timbalier and Timbalier Islands are presented in Table D.10-14.

Fill density to close the pass and build a permanent island section would be in the range of 250 – 350 cubic yards/ft. Considering that the pass is currently 1 mile wide, we estimate that about 1.3 to 1.8 million cy of sediments (preferably good quality sand) aided by temporary containment structures will be needed to close the pass. After the initial construction, if a stabilized design is constructed, about 320,000 cy per year will be necessary to maintain the islands (a 3.2 million cy project every 10 years). If a retreat design is chosen, about 550,000 cy per year (5.5 million every ten years) will be necessary to maintain the islands.

Table D.10-14. Estimated volume densities (in cy/ft) to restore and maintain Timbalier and East Timbalier Islands.

	Timbalier	Timbalier	East Timbalier	East Timbalier
Design Type	Retreat Design	Stabilized Design	Retreat Design	Stabilized Design
Design Fill	50	150	50	150
10 yr advanced fill	67	40	83	45
Initial Construction + advanced fill	117	190	133	195

10.6.8 Potential Sand Sources for the Area

Sand is a limited resource along the Timbalier Islands; suitable borrow areas adjacent to the island associated with paleo-deltaic systems may still be available and need to be confirmed by detailed geological investigations. Little Timbalier Pass (ebb- and flood-tidal shoals), local paleo-distributary channels, and channel maintenance material from Cat Island Pass may also provide fine sediments for marsh restoration, and/or sandy sediments for barrier island restoration. Ship Shoal is a promising deposit for the restoration and long-term maintenance of the Isles Dernieres and Timbalier Islands. Delivery strategies for moving Ship Shoal sands to the Isles Dernieres are being evaluated within the scope of CWPPRA projects TE-37 (New Cut Dune and Marsh Restoration) and TE-47 (Ship Shoal: Whisky West Flank Restoration). These projects may include rehandling of dredging material in navigation channels or dredged pits and access channels nearshore. For the Timbalier Islands, we suggest the use of Port Fourchon as a staging (re-handling) area for hoppers or scows that deliver Ship Shoal sands west of Belle Pass and Timbalier Island.

10.6.9 Research and Monitoring Needs and Further Plan Development

A detailed analysis of the LIDAR surveys taken in 2002 should be made to evaluate the performance of the fill placed in 2000. Bathymetric surveys would also aid in this endeavor.

The entire active profile of the constructed projects should be monitored (every five years and after major storms) to allow performance assessment and refinement of maintenance volumetric needs. Monitoring of shoreline configuration and barrier island area with remote sensing techniques (e.g. aerial photography, LIDAR, satellite imagery) should also continue. These tools can evaluate post-storm and long-term island area change rates.

A regional sediment budget that can be refined over time (GIS sediment budget) would help in the design and refinement of the volumetric requirements presented above.

10.7 Subprovince 3, Isles Dernieres

10.7.1 Geographical Location

The Isles Dernieres barrier island chain stretches for 20 miles along the Louisiana coast, about 63 miles west of the mouth of the modern Mississippi River and about 75 miles SW of New Orleans, Louisiana. The present configuration of this island chain includes the following islands, from west to east: Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island. The islands are separated by the following passes: Coupe Collin, Whiskey Pass, Coupe Juan, and Wine Island Pass (Figure D.10-21).

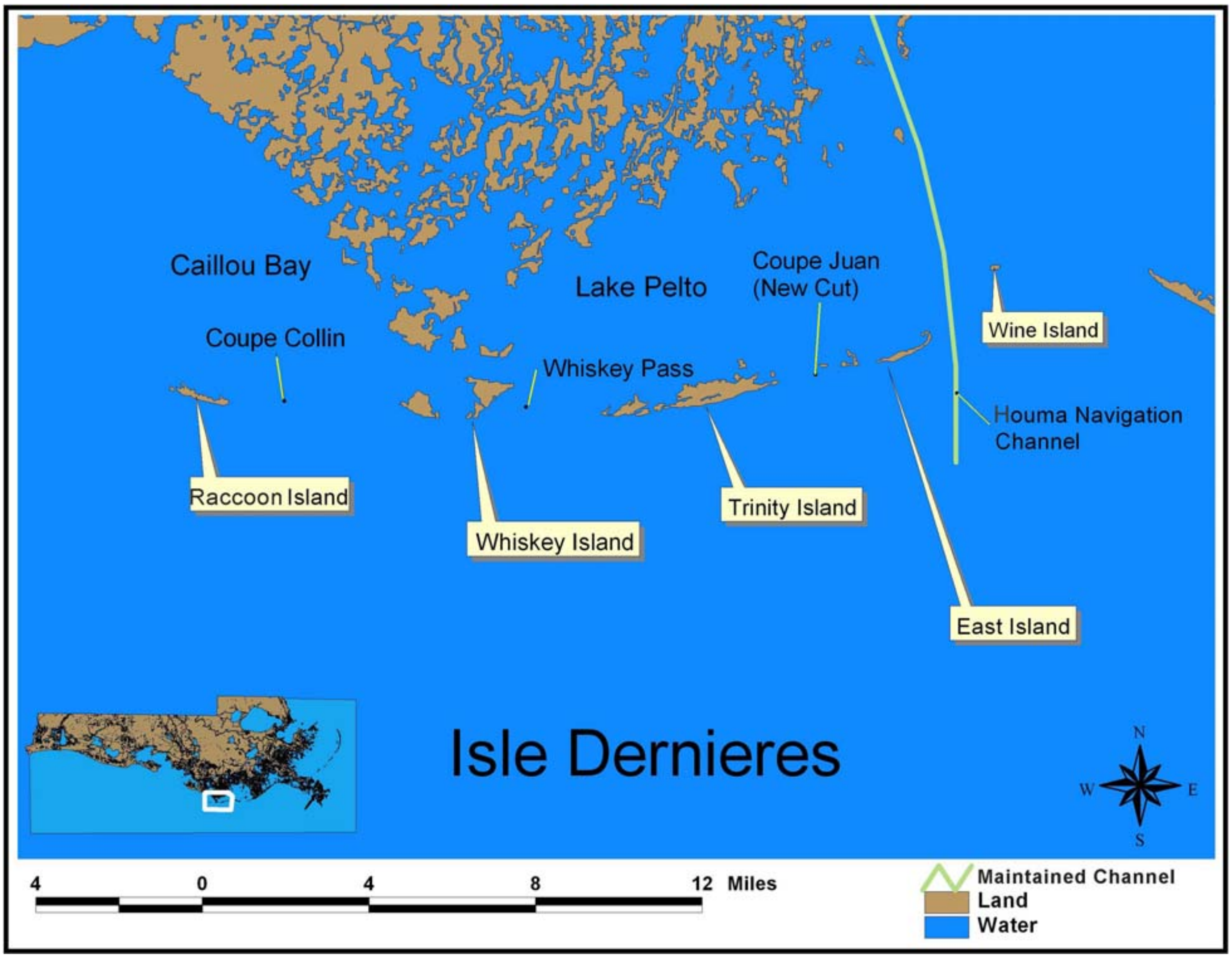

Figure D.10-21. Geographic Location of the Isle Dernieres (Raccoon, Whiskey, Trinity and East Islands) and associated inlets.

10.7.2 Geological Heritage and General Geomorphology

The Isles Dernieres were created by the reworking of sediments as the Lafourche delta's Caillou headland complex gradually submerged 600 to 800 years ago (Penland et al. 1987). The Isles Dernieres were divided into smaller islands by island breaching and tidal inlet development during the last century. The current islands contain regressive beach ridges, washover deposits, low elevation primary dunes, and marsh areas. The islands that compose the Isles Dernieres chain range from 0.15 to 1.2 miles (0.25 to 2 km) wide and are usually composed of a thin sand cap over a thick mud platform (Penland and Suter 1988). Elevations are generally low (e.g. mean dune height before construction of recent CWPPRA projects was in the range of 5 ft NAVD), and the islands are frequently overwashed. The submerged Gulfward profile takes a shape similar to sand equilibrium profiles for very fine sand from the shoreline to the approximately six foot contour.

10.7.3 Retreat Rates, Acreage Loss and Inlet Openings

The Isles Dernieres are some of the most rapidly deteriorating barrier islands in the United States. Measured retreat rates in the island chain during the last 100 years (long-term record presented in Table D.10-15) are on the order of 36.4 ft/yr on the Gulf side and 2 ft/yr on the bayside (Williams et al. 1992). Note that the mean Gulfside retreat was about 15 times greater than the bayside rate of progradation during the last century. As a consequence, the islands are converging and narrowing while migrating, and not rolling over and preserving area as anticipated. Long-term, short-term, and recent Gulf shoreline and bay shoreline change rates for the Isles Dernieres are shown in Table D.10-15.

Table D.10-15 demonstrates that most of the Isles Dernieres are eroding from both the Gulf side and marsh side, indicating that these islands may benefit from fill and structural protection of back barrier marshes. Higher retreats and area loss rates are verified in the middle of the chain (Whiskey and Timbalier) when compared with the two ends of the system (Raccoon Island to the west and East Island to the east). This indicates that Trinity and Whiskey Islands are acting as feeders for the Raccoon and East Islands respectively.

Despite the two-fold increase in magnitude of Gulf shoreline retreat (Table D.10-15), recent CWPPRA efforts in the late 1990s have helped maintain island area (Figure D.10-22).

The Isles Dernieres have an interesting history of tidal inlet openings and closings. For a detailed evolution of the morphology of the Dernieres system, see Williams et al. (1992). A summary of historical widths of the main inlets/passes is presented in Table D.10-16.

The most recent openings in the Isles Dernieres system include:

- Coupe Juan, termed recently New Cut. This opening was made in the late 1980s and is currently being considered for closure under CWPPRA project TE-27.
- Whiskey Pass
- Coupe Collin, which was named in 1956. However, a pass between Whiskey and Raccoon Island started to open in the early 1900s.

Table D.10-15. Long-term, short-term and recent shoreline change data for the Isles Dernieres. Data extracted from Williams et al (1992) (long-term and short term data sets) and Penland (in press) (recent data sets)

Islands	Gulf shoreline (ft/yr)	Bay shoreline (ft/yr)	Area (acres/yr)
	Long-Term Change Rates (more than 100 years of data)		
Isles Dernieres	-36.42	-1.97	-69.68
Raccoon	-23.62	-7.87	-19.03
Whiskey	-53.48	-5.58	-9.14
Trinity	-36.09	-5.25	N/A
East	-15.75	-8.86	N/A
	Short-Term Change Rates (1970's to 1988)		
Isles Dernieres	-62.99	-8.86	-116.63
Raccoon	-58.07	6.56	-16.80
Whiskey	-98.75	17.72	-31.38
Trinity	-58.40	-27.56	-46.70
East	-28.54	-28.87	-22.24
	Recent Gulf Shoreline Change Rates (1989-2002)		
Isles Dernieres	-61.50	N/A	N/A
Raccoon	-60.0	N/A	N/A
Whiskey	-86.0	N/A	N/A
Trinity	-62.0	N/A	N/A
East	-38.0	N/A	N/A

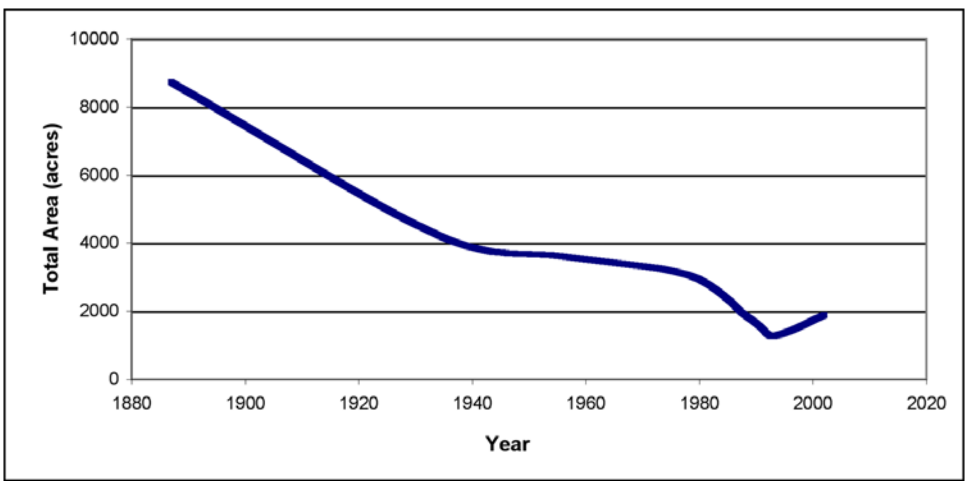

Figure D.10-22. Island area change for the Isles Dernieres during the last century.

Table D.10-16. Historical dimensions of main inlets/passes associated with Isles Dernieres. NA stands for data not available (inlet was non-existent or closed)

	1853	1890	1934	1956	1978	1988
Coupe Colin	NA	NA	NA	0.32	2.72	3.4
Whiskey Pass	NA	NA	0.32	0.92	0.76	2
Coupe Nouvelle	NA	NA	0.88	0.48	0.52	NA
Coupe Carmen	NA	NA	NA	NA	0.32	N/A
Coupe Juan (New Cut)	NA	NA	NA	NA	NA	0.6
Wine Island Pass	1.04	1.56	0.8	3.08	3.04	1.32

10.7.4 Island Dimensions

Mean island dimensions measured from Ritchie et al. (1989) (pre-CWPPRA projects) are presented in Figure D.10-23.

These dimensions correspond to a sub-aerial volumetric density of approximately 72 cy/ft. Island dimensions presented in Figure D.10-23 will differ from the present island configuration because of recent constructions and erosion. Slopes presented may be used as general guidance for design slopes.

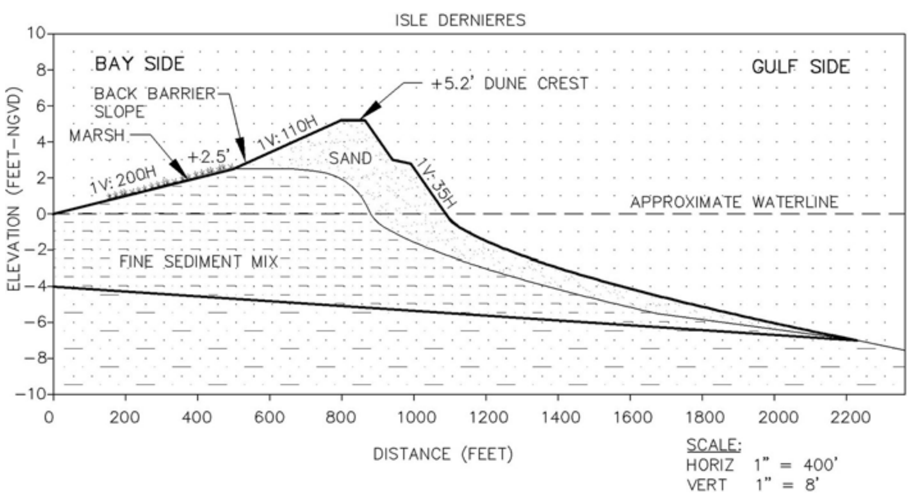

Figure D.10-23. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Isles Dernieres. Measurements originated from the cross-sections presented by Ritchie et al. (1989). The Figure D.10-is vertically exaggerated 50 times for display purposes.

10.7.5 Human Usage and Previous Restoration Projects

Isle Derniere means “last island” in French. The name was given to the chain in the 1800s to describe a single large island, which at the time was not separated by tidal inlets. Today the plural form of the original name “Isles Dernieres” is used to account for the multiple islands and inlets that occupy the former “last island” position.

Last Island was one of the Louisiana's first coastal resorts. By the mid 1800s, the island was the site of half a dozen vacation homes and two two-story hotels. The Isles Dernieres were reportedly impacted by several major hurricanes (e.g. the Last Island hurricane in 1956), which destroyed the homes and hotels and cost many lives. Continued retreat and narrowing of the islands and major hurricane impacts have prohibited further human occupation. Formerly, the single Isle Derniere provided significant wave shelter and storm protection to inland islands and mainland as well as salinity protection to bayside marshes and estuarine environments. In an effort to secure these benefits, several restoration projects were recently constructed by the CWPPRA program: East Island (TE-20), Trinity Island (TE-24), Raccoon Island (TE-29 and TE-48), and Whiskey Island (TE-27) (Figure D.10-24). Two projects are in the planning and design phase (Ship Shoal: Whiskey Island Western Flank, TE-47 and New Cut, TE-37). An example of the as-built survey of the Whiskey Island Project (TE-27) was provided by the LDNR field office team (Thibodeaux office) and is shown in Figure D.10-24.

Distinct design templates, volumes, and strategies were adopted for the protection of these islands. A section of Raccoon Island was protected by a series of detached breakwaters on its eastern tip. Whiskey Island was restored with a 5 foot dune with back barrier slope planted with dune and marsh vegetation (Khalil and Lee 2003). Trinity and East Islands were restored with an 8 foot dune and a backdune slope colonized by dune and marsh vegetation (Khalil and Lee 2003). An analysis of project performance based on island area (acres) created and maintained between 1996 to 2002 was presented by Penland et al. (2003). A summary of values of area increase and restoration cost per acre are indicated in Table D.10-17.

On Raccoon Island, where a structure-only stabilization approach was employed, a smaller area increase per dollar spent was realized. The greatest area increase was observed on East Island, followed by Whiskey and Trinity Islands. By analyzing volumetric densities placed on these islands, these varying performances can be explained (Table D.10-18). East Island showed a greater percentage of area increase (and increase rate) mainly because greater volumetric densities were used.

The smaller area increase observed on Trinity Island can be attributed to two main factors: (1) islands were built on top of the existing template, and (2) Trinity used a lower volumetric density. Whiskey Island used intermediate volume densities and a low-wide template. This resulted in almost the same area increase per dollar spent as East Island (Tables 17 and 18).

The volumes presented in the table above correspond to the as-built surveys. The total volume of sediments placed on the three nourished islands (Whiskey, Trinity, and East) is about 6.6 million cubic yards.

Table D.10-17. Percent area increase and restoration costs for the recently completed CWPPRA projects.

Island	Area Increase (%)	Positive Rate Increase	Restoration Cost (per acre)
Raccoon Island	9	+2.4	150,421.000
Whiskey Island	36	+42.0	45,953.000
Trinity Island	15	+23.2	116,631.000
East Island	97	+46.9	46,717.000

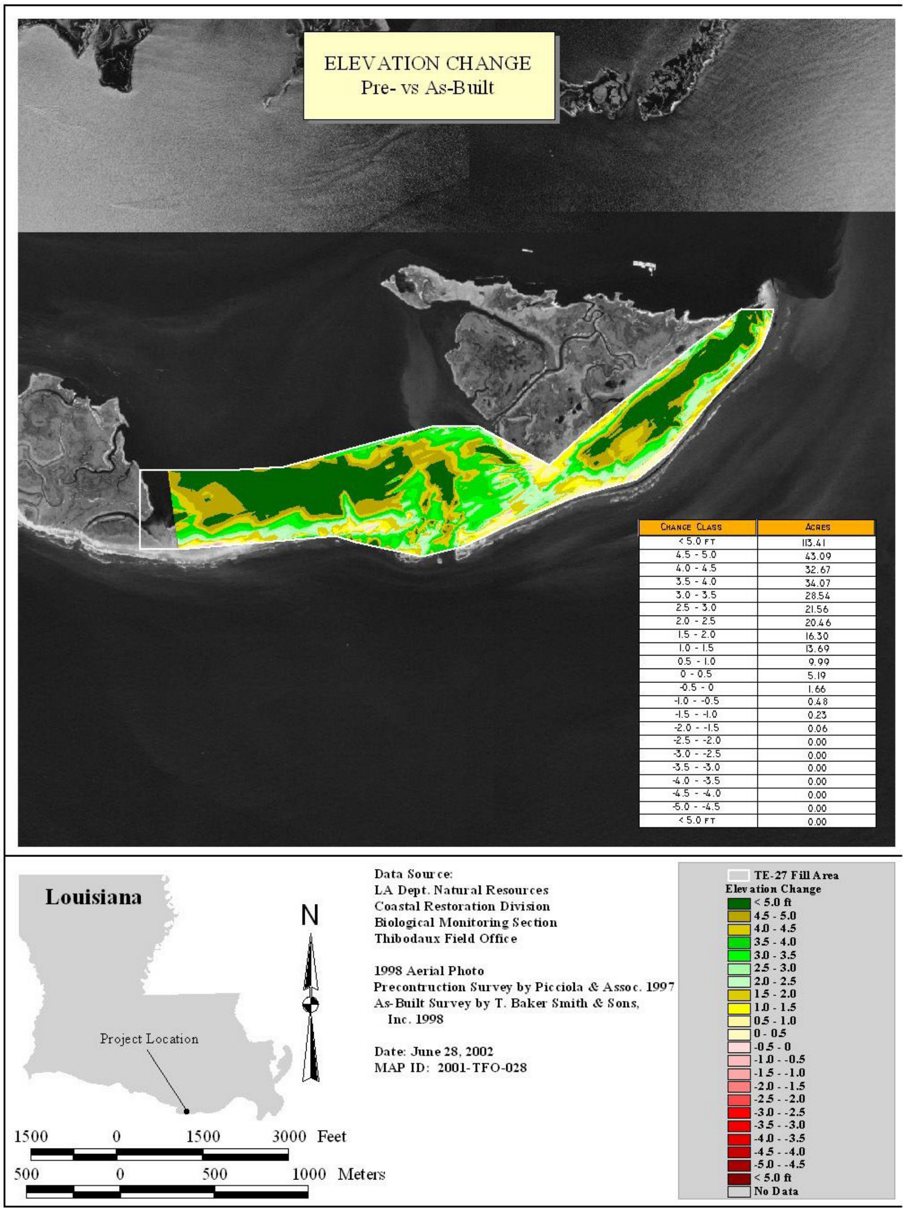

Figure D.10-24. Digital terrain model of the as-build surveys of the Whiskey Island restoration project.

Table D.10-18. Volumetric densities used in the Isles Dernieres nourishment projects.

Constructed Projects	Approximate Total Volume*	Approximate Project Length (ft)	Approximate Density (cy/ft)	Design Lifetime	Density per year (cy/ft/yr)
Whiskey Island (TE27)	2,246,301	12,000	187.2	20	9.4
East Island (TE 24)	2,624,587	10,650	246.4	20	12.3
Trinity Island (TE 20)	1,767,866	12,500	141.4	20	7.1

10.7.6 Identification of Best Management Strategies for the Area

Adaptive management practices should start immediately in the Isles Dernieres with the analysis of the performance of three CWPPRA projects recently constructed (East, Trinity, and Whiskey Islands). A detailed comparison of current island configurations using the most recent data sets (e.g. 2002 LIDAR surveys) with the as-built configurations of the three CWPPRA projects would provide significant guidance to further refine design strategies. In the absence of such an analysis, the following discussion is based on comparisons of CWPPRA project volume densities with historical data (pre-projects) and conceptual analysis methods developed by the LCA team.

Volumetric analysis of these projects (as-built surveys) compared to historical island behavior and mechanisms of volume loss in the barrier islands indicate that: (1.) at Whiskey and East Islands, the volume placed was equivalent to a retreat design volume plus about 10 years of advanced fill or about 15 years of advanced fill without the initial design fill; (2.) at Trinity Island, the volume placed was equivalent to a retreat design volume plus about 15 years of advanced fill, or 20 years of advanced fill without the initial design fill. Based on these estimates, strategies suggested for the Isles Dernieres include upgrading the current islands to a more stable configuration (stabilized design) with Ship Shoal sands (this can be achieved by adding density of about 100 cy/ft of sand), monitor (bi-annually or every five years and after major storms), and re-nourish the islands every 10 years to preserve the templates. Nourishment components for the upgraded design of the Isles Dernieres will include seaward storm protection berms, dune systems with uniform elevations, and bayward extension of marsh platforms. Volumes associated with the maintenance of the stabilized design and current designs for the Isles Dernieres are presented in the next section.

The renourishment projects will perform better and be easier to construct than initial nourishments because: (1.) island breaches were already closed, (2.) the island exhibits the design cross-sections, and (3.) the new source (Ship Shoal) contains superior quality sand (fewer silts).

The areas that need immediate fill are the two projects being planned: the west flank of Whiskey Island and the breach between East and Timbalier Islands, also known as New Cut; and Raccoon Island. If breakwaters are going to be maintained at the east end of Raccoon Island, then a fixed design should be built and nourished at higher initial densities. Closure of Whiskey

Pass should be evaluated using hydrodynamic and economic analyses. A hydrodynamic investigation should also be undertaken to manage and/or re-direct tidal flow from Lake Pelto. Closure of Coupe Collin will be more difficult to achieve because of rise width (about 5 miles) and deeper waters. If the passes are closed, a fixed design would be an appropriate selection for the closed pass segment as well as the adjacent islands.

Historical retreat rates indicate that Whiskey and Trinity Islands represent a source of sediments for the ends of the systems (Raccoon and East Islands). Therefore, it is recommended that higher densities of seaward fill be placed in the central islands (Whiskey and Trinity) so that they can continue to feed adjacent barrier islands.

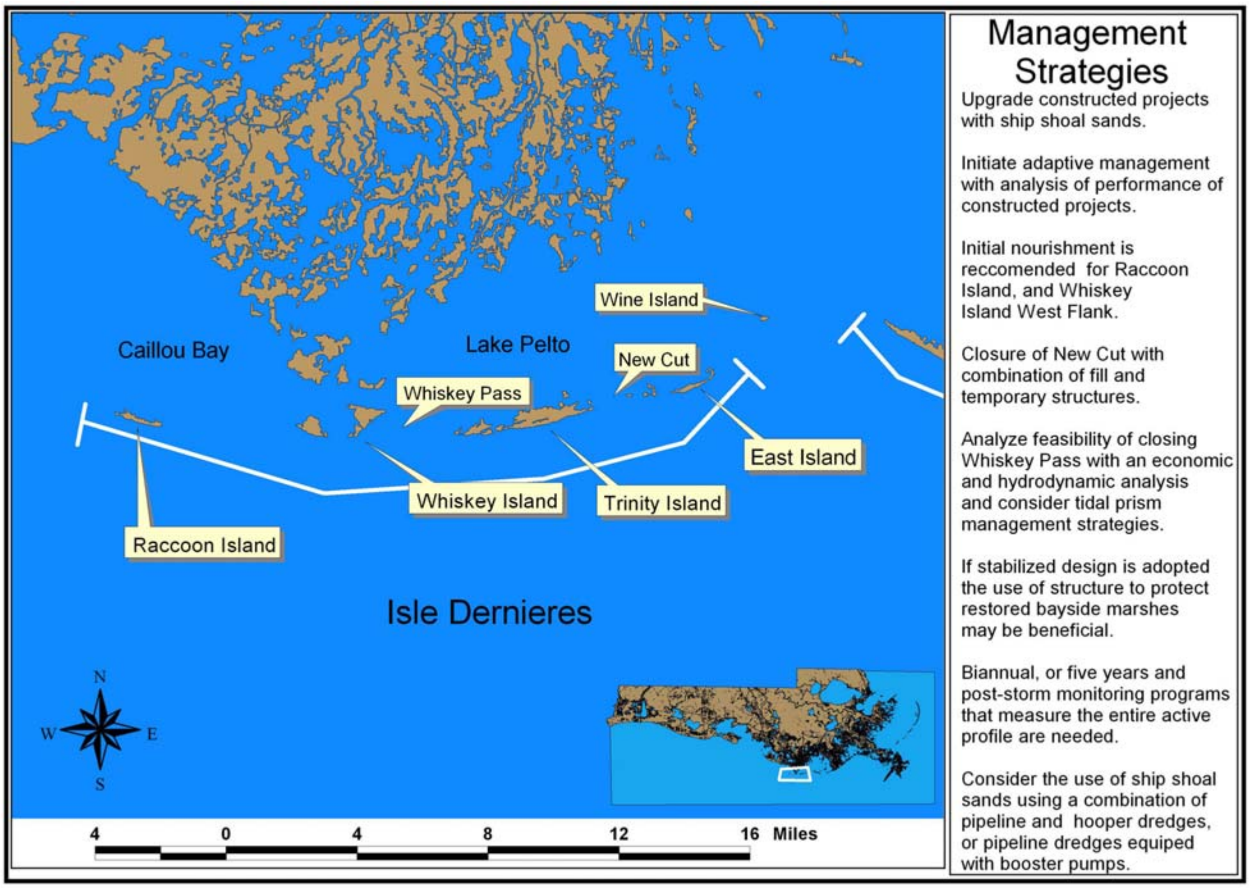

Figure D.10-25. General programmatic strategies proposed for the Isle Dernieres.

Lessons learned from earlier constructions should be considered in order to improve future restoration plans. These lessons include:

- Acreage loss trends of barrier islands can be reversed by introducing significant quantities of sediments to the system.
- Beach fills are more cost effective ($ per acre) than structures for protection of migrating barrier islands.
- Volume densities play a more important role than design template in the success of the project.

- Containment of back barrier fills is needed.
- Marsh planting success can be improved by waiting for the constructed grade to settle prior to planting.
- Use longitudinally aligned sand fencing. Oblique and perpendicular dune fences create low spots downwind that favor breaching.

General strategies for the Isles Dernieres are summarized in Figure D.10-25.

10.7.7 Determination of Volumetric Requirements

Volumes necessary for the initial construction (enhancement of constructed islands + advanced fill and initial construction) are shown in Table D.10-19.

Table D.10-19. Volumetric needs for enhancement of constructed islands, initial construction of Raccoon Island, and maintenance needs (advanced fill).

STABILIZED DESIGN				
	Raccoon	Whiskey	Trinity	East
Fixed Design Fill	140	100	100	100
10 yr advanced fill (maintenance)	40	58	58	45
Initial Construction (10 yr lifetime)	180	158	158	145
RETREAT DESIGN				
	Raccoon	Whiskey	Trinity	East
Retreat Design Fill	50	0	0	0
10 yr advanced fill (maintenance)	67	133	133	83
Initial Construction (10 yr lifetime)	117	133	133	83

Because of the proximity of Ship Shoal to the Isles Dernieres it will be more cost-effective in the long run to build a continuous stabilized design from Whiskey to East Island using high initial densities of clean sand. This will facilitate permanent closure of the passes. Terminal structures (e.g. terminal groins) should be considered on the east end of East Island if the stabilized design is constructed. Wine Island (downdrift) should then be maintained with a retreat design using sediments from the maintenance of the Houma Navigation Channel.

If the entire Isles Dernieres chain (including the two projects being planned viz. Whiskey and New Cut and Raccoon Island) is restored to a fixed design density, it is estimated that the annual maintenance needs for the entire island chain will fluctuate at approximately half a million cubic yards per year (500,000 cy/yr) of sand, or about 5 million cubic yards for a 10 year renourishment cycle. Maintenance needs may decrease with time as the islands translate from a thin veneer of sand on top of mud to a predominantly sand system.

10.7.8 Potential Sand Sources

Sand sources for the beach and dune construction include nearshore ebb-tidal shoals (e.g. Coupe Collin, Cat Island Pass), relict spits (e.g. Raccoon Island paleo relict spits), and paleo distributary channels adjacent to the islands. These deposits should be investigated by targeted geotechnical and geophysical investigations.

Sources of sediment mixtures for marsh restoration include channel dredging of the Houma Navigation Channel (about 350,000 cy per year from 1960 to 1980) and various sources adjacent to the islands (Penland and Suter 1988; Suter et al. 1991). For stabilized designs, the marsh construction should be built behind the active beach profile if mixed sediments are used.

Ship Shoal, which is located about 8-12 miles (14 to 20 km) offshore, represents a promising source for the long-term maintenance of these islands. Because of the proximity of the shoal to the Isles Dernieres, sand may be dredged and delivered to the coast by pipeline dredges equipped with booster pumps (e.g. the Beach Builder constructed specifically for this application). The use of Ship Shoal sands for the Isles Dernieres will be cheaper than for other Louisiana barrier islands. As a result, the construction of denser fill composed of sand with very low silt (stabilized design) will be more cost effective on the Isles Dernieres than would usually be the case.

10.7.9 Research and Monitoring Needs

An immediate and detailed engineering analysis of the constructed projects is needed. This analysis should compare current island configurations with as built configurations, calculate volumetric losses per year, and track movement of the lost material. Bathymetric/submerged profile surveys would complement existing topographic data (LIDAR) in this analysis. Monitoring and analysis of project performance, both in subaerial and submerged sections of the island, should be performed to provide guidance for future projects. Future monitoring needs include:

- Continue to monitor island area using aerial photography and LIDAR. Data should be analyzed to show volumetric and shoreline changes. The data can also identify the shapes and slopes that the islands are taking under the impact of waves, storms, and wind forcings.
- Conduct hydrographic surveys of submerged beach profiles in phase with surveys of the subaerial portion. This should be done on a bi-annual or five year schedule and after major storms. Consider the use of sea sleds to measure submerged profiles in order to achieve the high accuracies needed in a very flat environment.
- Conduct surface sediment sampling of the seabed offshore and adjacent to the islands. This will help track sand transport and distribution offshore.

Monitoring data should be used to refine a local sediment budget and to further develop the conceptual model of dominant sediment transport processes. The results should then be used to enhance design and constructability of future projects. The volumetric estimates presented herein are believed to be in the range needed to maintain these islands for the long-term, however refinement of these initial estimates should be performed based on data from detailed monitoring of constructed projects.

10.8 Subprovince 3, Point Au Fer to Fresh water Bayou

10.8.1 Geographical Location

The stretch of coast between Point Au Fer and Freshwater Bayou extends for about 80 miles through the central part of the Louisiana coast, about 20 miles south of Morgan City (Figure D.10-26). This stretch of coast includes the oldest sections of the Mississippi River Deltaic Pain. The coast is predominantly erosional and characterized by washover terraces, perched beaches, and erosional scarps. A remarkable feature of this coast is the Atchafalaya Delta, a modern bifurcation of the Mississippi River down the Atchafalaya River past Morgan City. Along the coast's western stretches near Cheniere Au Tigre and Freshwater Bayou are prograding mudflats sourced from the Atchafalaya River.

10.8.2 Geological Inheritance and General Geomorphology

Point Au Fer Island, Marsh Island, and the eastern flank of the east Chenier Plain are comprised of alternating chenier ridges and intervening marshes. Reworking of deltaic materials with admixtures of oyster shells formed a complex pattern of chenier ridges. The marshes grade north from predominantly Holocene marsh deposits to a vast area of swamp bounded by Bayous Teche and Lafourche. The northern flank of the marsh abuts a higher-lying Pleistocene terrace. Point Au Fer and Marsh Islands are separated by Atchafalaya Bay, which contains remnants of historically more extensive oyster reefs (Figure D.10-26). West of Southwest Pass, which exchanges water between the Gulf of Mexico and Vermilion Bay, the continuous marshes merge with a classic chenier ridge topography backed by extensive marsh deposits.

Beach sediments range from shell-rich accumulations with a fine grained sand matrix (mostly shells) to shelly sand deposits (mostly sand). The provenance of fine-grained sediments is the Atchafalaya and Mississippi rivers. Delta front sands in the Trinity/Tiger Shoal off Marsh Island, which supplied sandier sections of the modern beach, may constitute future sources for shoreline restoration.

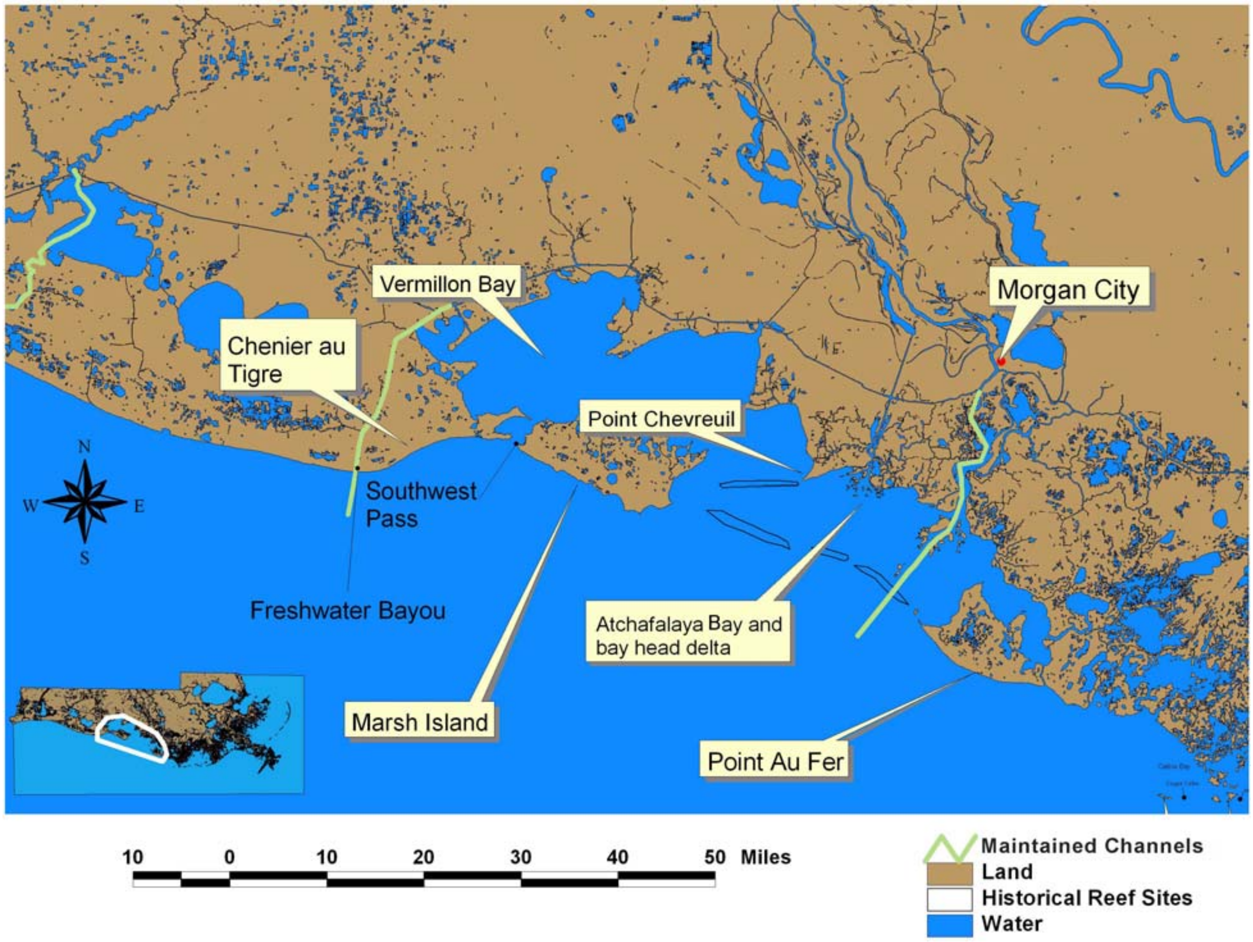

Figure D.10-26. Geographic location of the coast between Point Au Fer and Marsh Island.

10.8.3 Retreat Rates, Acreage Loss, and Inlet Openings

The sedimentary and morphological dynamics of this area are tied to the delta switching of the Mississippi River. Work carried out along the coast and adjacent mudflats indicated that somewhere between 1946 and 1948, an initially erosional coast became stable to progradational (Morgan et al. 1953; van Lopik 1955; Morgan and Larimore 1957; and Morgan 1963). This significant change in coastal response affected some 15 miles (25 km) of the eastern flank of the Chenier Plain and was attributed to the persistent capture of Mississippi River discharge by the Atchafalaya distributary. Work by Morgan and Larimore (1957), summarized by Stone and McBride (1998), showed that while the Chenier Plain coast was historically retreating at a rate of 18 ft/y (5.6 m/yr.), Chenier Au Tigre was prograding at about 13 ft/yr (4 m/yr). Shoreline behavior is quite variable, with localized erosion about 30 ft/yr in some areas, stable sections, and accreting mudflat on the southwestern end of the chenier (attributed to Atchafalaya sediments by Adams et al. 1978).

Recent Gulf shoreline retreat rates in the chenier coastal segment are relatively low compared to other sections of the Louisiana coast. A comparison between Gulf shore retreat rates for the periods from 1955 to 1978 and 1985 to 1998 shows a general decrease in the magnitude of shoreline retreat (Table D.10-20).

Reasons for the smaller retreat rates include: (1) age of associated deltaic systems; (2) recent mud-flat accretion induced by the Atchafalaya River; (3) lower nearshore wave energies due to wave dissipation by fluidized muds and nearshore oyster reefs (Sheremet and Stone 2003). No data regarding inlet openings and area changes for this coastal segment were readily available in the literature.

Table D.10-20. Gulf shoreline retreat rates for Point Au Fer and Marsh Island. Data for the period between 1955 to 1978 was extracted from van Beek and Meyer Arendt (1982). The data set for the period between 1985 to 1988 was proved by Penland (2003, in press)

	Gulf Shoreline Retreat Rates (ft/yr)	
	1955-1978	1985 to 1998
Point Au Fer (mean)	-16.7	-9.7
Marsh Island to Freshwater bayou (mean)	-11.6	-6.8
Marsh Island (Southwest Pass to Lake Point)	-14	-6.4
Southwest pass to Chenier au Tigre	-11	-8.5
Chenier Au Tigre to Freshwater Bayou	-10	-5.6

10.8.4 Unique Characteristics

This is a unique section of coast due to the influence of the Atchafalaya River and its debouching of fine sediment (silts and clays) into the Gulf coastal zone (Figure D.10-27). Subsequent effects of fine grained sediment on the inner shelf are particularly important in determining trends in wave propagation and nearshore wave-current properties.

Here, waves typically range between 0.5 and 1.0 m during winter storms associated with fronts, but the waves are significantly attenuated (Stone and Sheremet 2003). Attenuation effects in this muddy environment are higher during the same storm event than in adjacent sandy sites. The apparent wave attenuation, or dampening effect, plays an integral role in mud flat accretion along the eastern chenier complex. The conventional paradigm that storms result in coastal erosion does not apply here. Wells (1983), Kemp (1986), Roberts et al. (1989) and Huh et al. (2001) document the importance of storm waves in mud flat accretion along the beach during winter cold fronts. Pre-frontal events typically involve lower frequency waves generated by strong wind from the south. This results in setup along the coast and deposition of mud on the beach. Post-frontal winds from the north create rapid wave set-down and lowered water levels that, in turn, result in mud flat exposure. Approximately 20 to 40 cold fronts pass through the area each year (Chaney 1999), which suggests that these events have a significant effect over longer time scales. An important, but seldom discussed phenomenon is the effect of oyster reefs on local coastal processes. An historic bathymetric map of the inner shelf and Atchafalaya Bay is presented in Figure D.10-28. The Figure D.10-shows reef location and spatial extent compared to a recent map of the area that shows significantly fewer reefs. Throughout the 20th Century, many reefs were dredged, and the bay and adjacent shorelines began transforming from low-energy protected environments to higher energy, open marine systems. Historically, the Atchafalaya and Wax Lake deltas and adjacent shorelines were protected from wave impacts and potential erosion. This degree of protection is no longer provided by the reefs.

Figure D.10-27. Satellite image of Atchafalaya Bay showing the infusion of fine-grained sediment into the bay with decreasing suspended sediment concentrations towards the Gulf of Mexico. (Image obtained from Earth Scan Lab., Coastal Studies Institute, Louisiana State University).

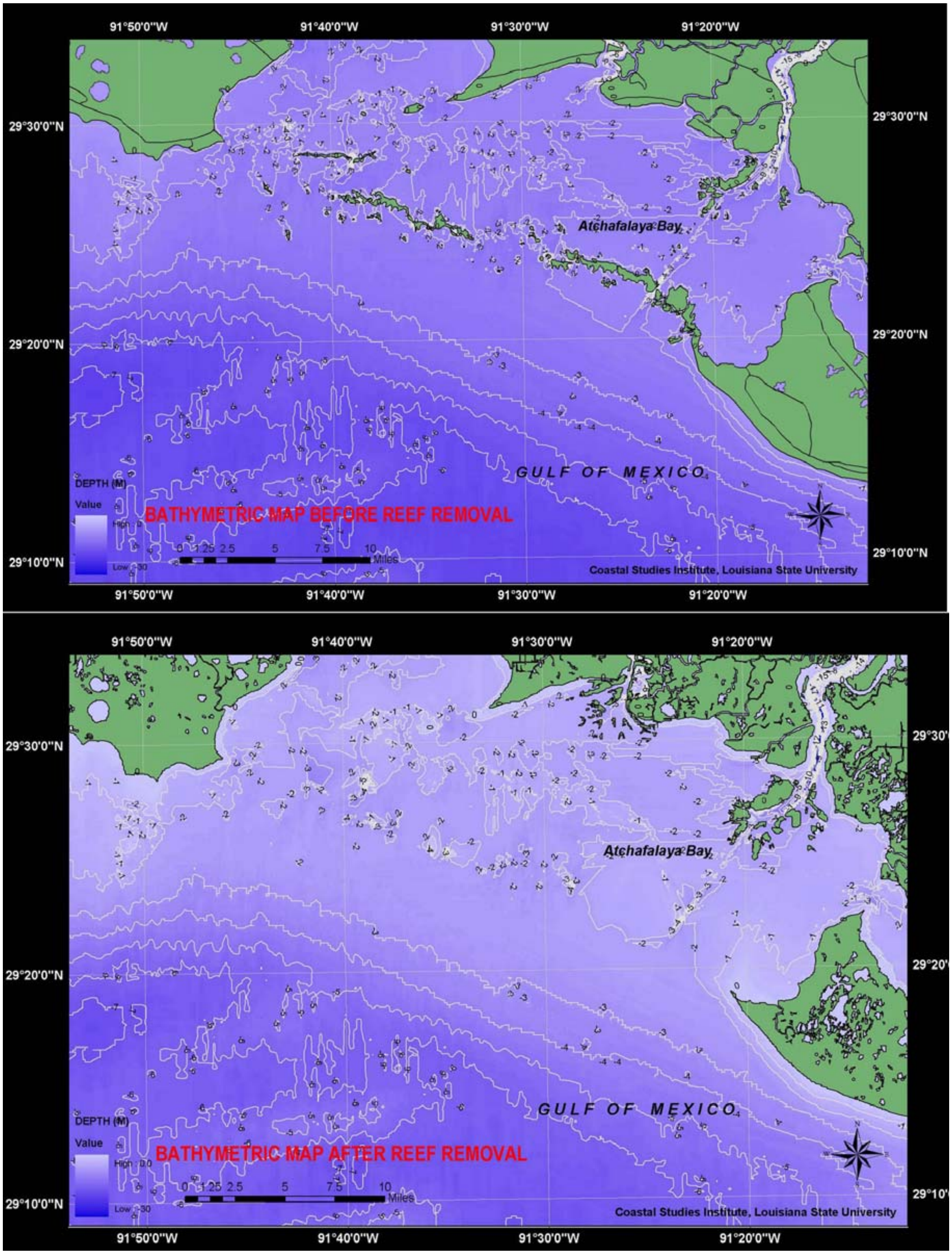

Figure D.10-28. Bathymetric map of the Atchafalaya Bay and inner shelf prior to the gradual dredging of oyster reefs (top) and bathymetric map of the inner shelf and Atchafalaya Bay area after removal of oyster reefs (bottom).

10.8.5 Island Dimensions (Slopes, Heights)

No cross-sectional profiles or recent topographic surveys were available for this coastal segment, limiting the analysis of island dimensions.

10.8.6 Human Use and Recent Projects

The Atchafalaya, while active since the 1500s, is prevented from capturing the Mississippi River by a control structure built in 1963 and maintained by the U.S. Army Corps of Engineers. The Atchafalaya carries approximately 84 million metric tons of sediment onto the shallow shelf annually (Wells and Kemp, 1981). Two CWPPRA projects were constructed in this region, Marsh Island Hydrologic Restoration (TV-14) and Point Au Fer Canal Plugs (TE-22).

Interventions on Marsh Island date back to 1950 when a cut was dynamited (Dynamite Cut) connecting east Branch Oyster Bayou with Bayou Blanc. This cut increased water exchange between Gulf waters and interior marshes, causing significant environmental impacts. In an attempt to restore original hydrologic conditions, the cut was plugged in the 1950s. However, the cut has since reopened due to natural coastal processes, and it has remained an open pass ever since. Several oil field canals were constructed in the vicinity of Marsh Island in the late 1950s, and canal dredging formed spoil banks that were later colonized by marshes. Recently, accelerated subsidence contributed to rapid degradation of these banks, resulting in the opening of several new cuts. This has lead to greater tidal exchange, tidal scouring, and increased salinities in the interior marshes causing marsh loss (USACE 1994).

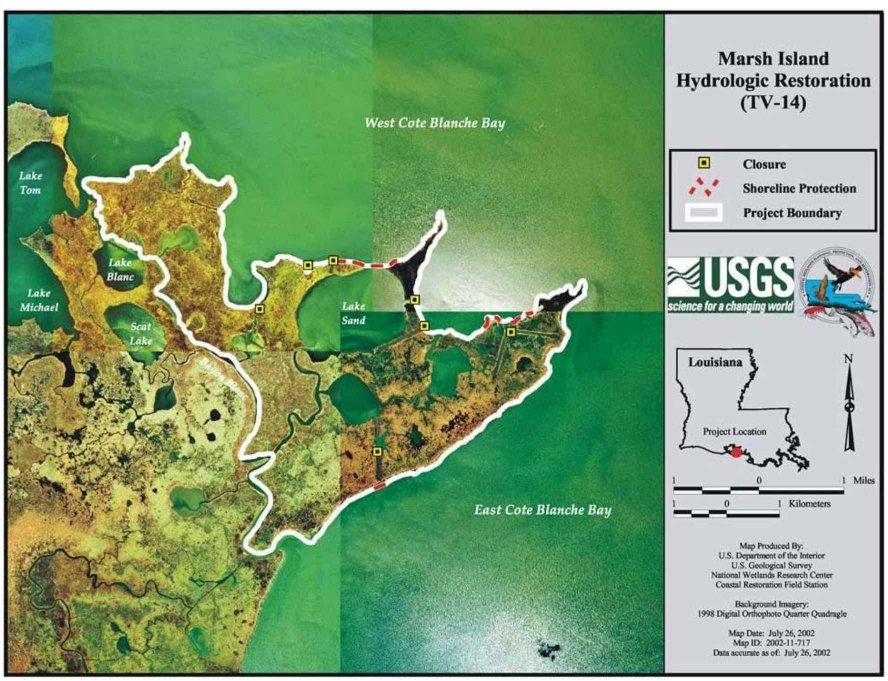

Figure D.10-29. Marsh Island hydrologic restoration project showing project area and primary land-water features.

Recent efforts of the CWPPRA program include: (1.) stabilization of northeast shoreline of the island with approximately 2,000 ft of rubble mound breakwaters, (2.) stabilization of the north shore of lake sand with about 3000 ft of breakwaters, and (3.) plugging of nine oil field access canals with low-level dikes and earthen materials (Figure D.10-29). The project's main objectives were to protect interior marshes, maintain island area, and attempt to restore natural hydrological conditions (CWPPRA 2001). Project performance has not yet been analyzed. In Point Au Fer, seven man-made canals were plugged with earthen material with sediment to protect against island breaching and reduce penetration of storm surges and high tides to the back barrier canals.

10.8.7 Identification of Best Strategies for the Area

Restoration strategies for this area include the construction of artificial reefs from Point Chevril to Marsh Island (Portugal Reefs to protect mainland marshes and the development of a delta sediment management plan at the mouth of the Atchafalaya River to maximize land building in the area. Point Au Fer and Marsh Island were not recommended for restoration due to accretion in this coastal segment.

Analysis of these areas indicates that recent erosional trends on Marsh Island and Point Au Fer are mainly due to human-induced hydrologic changes (related to the construction of canals), increased rates of subsidence, and tidal-wave induced erosion.

Habitat loss on Marsh Island and Point Au Fer is mainly due to modified hydrological conditions and breaching and weakening in areas near man-made canals. Breaching in these threatened areas results in increased saltwater intrusion to interior marshes and ultimately in marsh loss. Therefore, restoration strategies recommended for these coastal segments include plugging (infilling) other artificial canals that are not in use by oil companies. This will help restore a natural hydrological regime and provide salinity protection to interior marshes.

The oyster reef complex between Point Chevreuil and Marsh Island should be considered for further restoration to protect interior marshes and habitats behind Marsh Island (Vermilion Bay). This restoration should be achieved by sediment transfer from the adjacent Trinity Shoals, but may also be accomplished with low crested/low density structures. The oyster reef complex that existed in front of the modern Atchafalaya Bay head delta is not recommended for immediate restoration because accretion due to sediment input from the Atchafalaya is observed landward of these reefs.

On the eastern flank of the Chenier Plain, performance monitoring of constructed experimental breakwaters (CWPPRA TV-16) is recommended. Enhancement of the breakwaters' performance may be achieved with sediment introduction and should be considered. Retreat rates in these coastal segments (Point Au Fer, Marsh Island, Chenier Au Tigre to Freshwater Bayou) are relatively low (see Table D.10-20), erosional areas are localized, wave climate is relatively mild (Sheremet and Stone 2003), and there is potential for sediment deposits in the vicinities of the island and further offshore (Suter et al. 1991). Therefore, maintenance costs for a nourishment program that will stabilize this segment of the Gulf shoreline would be low when compared to other barrier islands along the Louisiana coast. Restoration components may include marsh restoration/extension in back bay areas and beach and dune fill. A beach and dune fill in the Gulf shoreline would prevent breaching and would provide storm and salinity protection to backbarrier marshes. Because this area has large amounts of cohesive segments on both the Gulf and bayside shorelines, geotechnical studies to account for settling of the substrate after construction with a sand overburden may be required and included in design considerations.

Suter et al. (1991), using coarsely spaced seismic data and few vibracores, indicated that several potential deposits occur in this coastal segment. Sediments with mud overburden and variable textural properties and a high potential for fine sand (e.g. 60-95% sand as indicated by Suter et al. 1991) include several infilled paleo distributary channels (e.g. Marsh Island Distributary Channel; Western Shell Reef Distributary Channel; Central Shell Reef Distributary Channel; Eastern Shell Reef Distributary Channel; and Western, Central and Eastern Point Au Fer Distributaries). Other geomorphological settings that may have clean sand with minimal or no overburden are paleo shoals located further offshore (e.g. shoals located offshore at about 20 miles southeast of Marsh Island or 20 miles southwest of Point Au Fer). These deposits should be further investigated with detailed geotechnical and geophysical surveys. The management strategies proposed for the Point Au Fer to Freshwater Bayou segment are presented in Figure D.10-30.

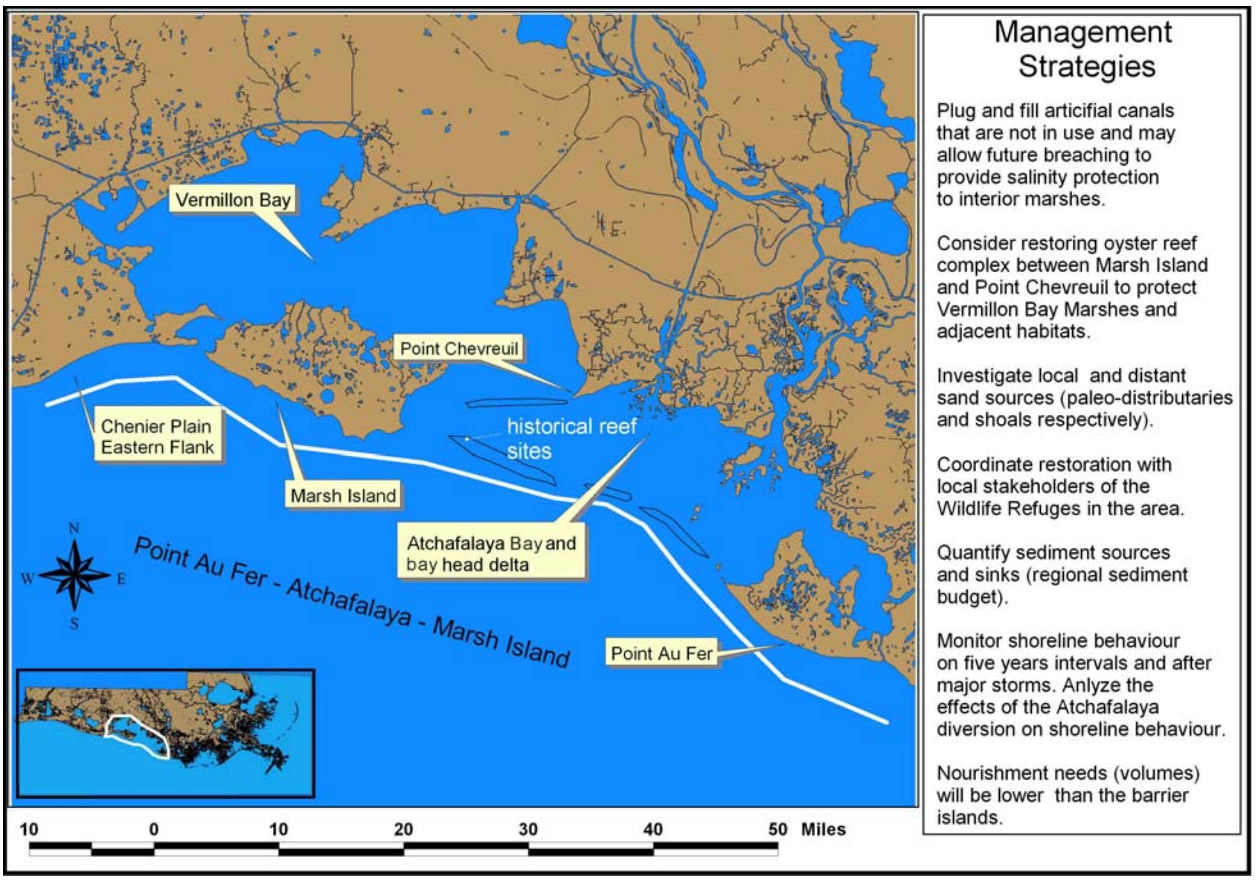

Figure D.10-30. Proposed general management practices for the coast between Point Au Fer and Freshwater Bayou.

The nourishment program would work in conjunction with sediment input from the Atchafalaya diversion. Therefore, the expected project lifetime may be increased. If a nourishment program is adopted for this coastal segment, periodic sediment introduction should be complemented by a monitoring program that effectively identifies and maps erosional areas. A detailed quantification of coastal dynamics and sediment budget for this area is also lacking and would aid in understanding and planning future restoration needs.

Future restoration efforts for this area should consider that Marsh Island is a Wildlife Refuge owned and operated by the state of Louisiana and that close coordination with local stakeholders is required. How well the Atchafalaya diversion is be able to minimize erosional problems of this area in the near future should be investigated by continuous monitoring.

10.9 Subprovince 4., Eastern Chenier Plain (Freshwater Bayou to Calcasieu Pass)

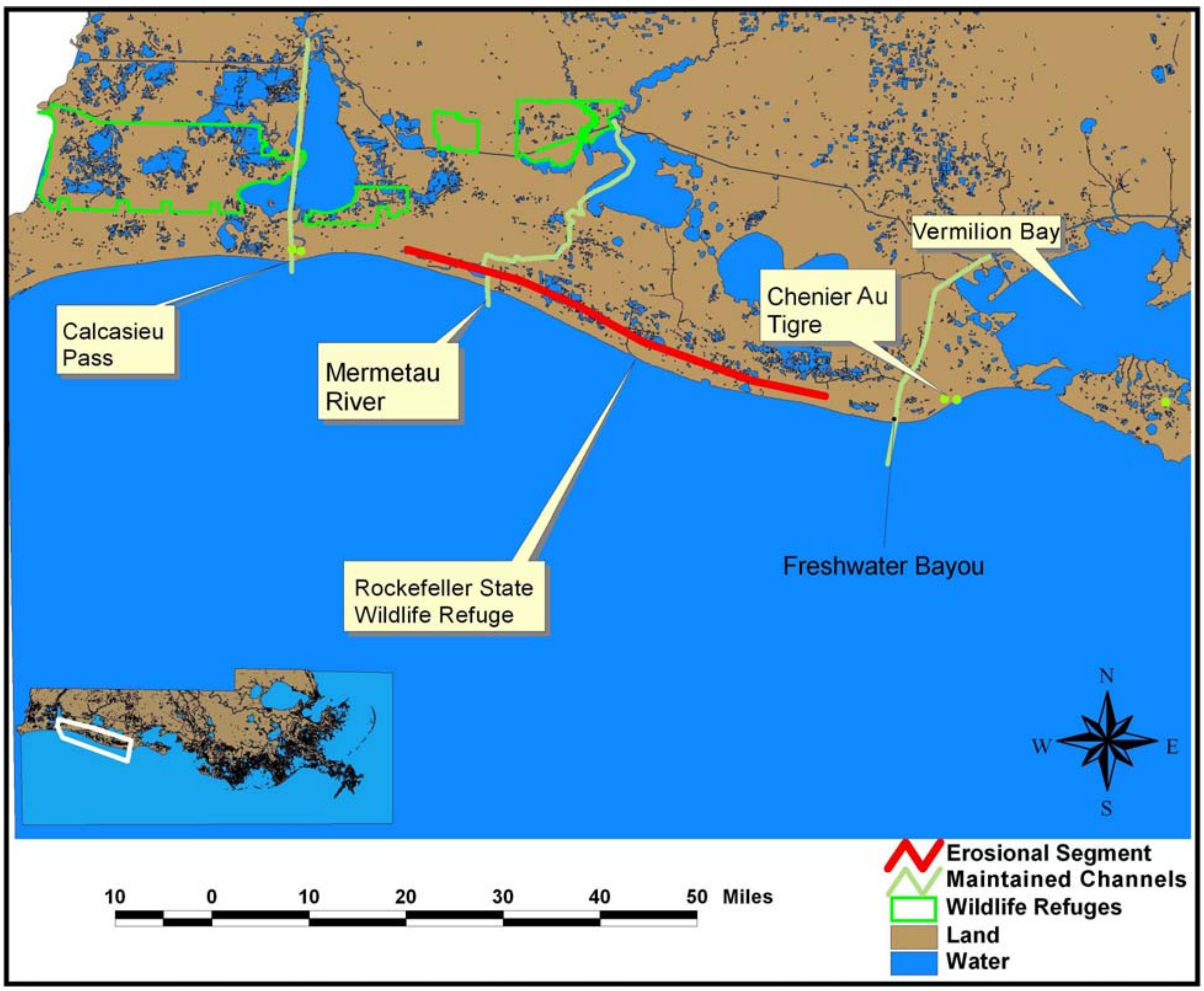

Figure D.10-31. Geographic location of the coast between Freshwater Bayou and Calcasieu Pass.

10.9.1 Geographical Location

The eastern segment of the Louisiana Chenier Plain is located between Freshwater Bayou and Calcasieu Pass (Figure D.10-31). This segment ranges from 11 to 12 miles in width (18 to 20 km), and is composed of ridges averaging 3 to 5 ft high.

10.9.2 Geological Inheritance and General Geomorphology

The geology of this coastal segment is characterized by classic chenier ridges backed by marsh deposits. Chenier ridges are defined in the literature (Hoyt 1969) as coarse clastic ridges intercalated with mudflats. These features are formed by alternating pulses of mudflat progradation and marine reworking (Hoyt 1969; Penland and Suter 1989) (Figure D.10-32).

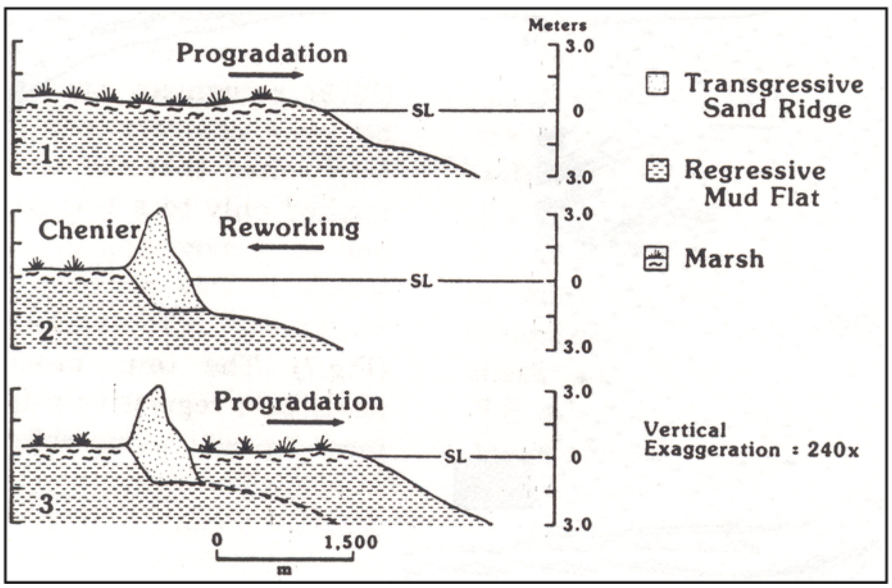

Figure D.10-32. Formation mechanisms of cheniers, from Hoyt (1969).

10.9.3 Retreat Rates

This coastal segment is predominantly erosional in the central segment (Rockefeller and Mermentau segments) and accretional (mudflat accretion) on both east and west ends (updrift of Calcasieu pass and vicinities of Freshwater Bayou respectively).

The area west of Freshwater Bayou and the Mermentau River jetties (about 40 miles long) predominantly eroded at an average rate of 28 ft/yr (8.6 m/yr) from 1883 to 1994, according to Byrnes and McBride (1995). Long- and short-term shoreline changes for this section of the Louisiana coast was compiled by Penland et al. (2003) (Table D.10-21).

Table D.10-21. Short and long-term Gulf shoreline change rates for the eastern Chenier Coast.

	Gulf Shoreline Retreat Rates (ft/yr)	
	1883-1994	1985 -1998
Calcasieu Pass to Old Mermentau River	11	-9.6
Old Mermentau River to Rockefeller Refuge West	-18.7	-24.4
Rockefeller Refuge West to Rockefeller Refuge East	-34.8	-39.2
Rockefeller Refuge East to Mulberry Island	-25.0	-16.9
Mulberry Island to Freshwater Bayou	9.2	68.4

10.9.4 Human Use and Previous Projects

Several important wetland environments and nesting grounds are present in this section of the coast. The presence of oilfields, man-made canals, and navigation channels landward cause weak spots that are susceptible to breaching. This, in turn, contributes to shore deterioration and salinity increase in interior marshes. These events negatively impact thousands of acres of valuable marsh environments and associated habitats.

A nine mile segment of this coast is currently being considered for restoration. After investigating the feasibility of several restoration strategies. Shiner and Mosley (2003) recommended restoration using a combination of low-crested reef breakwaters made from lightweight aggregate core and concrete panel breakwaters. Consideration of distant sand sources and the cost of this distant material lessened the desirability of sand solutions in the preliminary study. The western Louisiana coast, however, contains extensive fields of incised paleo-river valleys (Berryhill 1986; Penland 2003; Figure D.10-33) that may contain significant quantities of sediments at much lower prices than what was anticipated by the preliminary study. One of the channels shown in Figure D.10-33 was successfully explored by CPE (2002) for the Holly Beach restoration project using sand at a cost of $5.25 cy. Location of nearby sand sources could bring the cost for sand solutions below that of the recommended breakwaters for the area (CWPPRA Project ME-18).

10.9.5 Identification of Best Strategies for the Area

We suggest that an offshore sand investigation be performed in this region. If closer (less expensive) sand can be located, sand solutions should be revised.

If only structural solutions—with no introduction of new sediments to the system—are adopted, the temporary erosion relief of a given coastal segment may occur at the expense of eroding adjacent, downdrift segments. Foundation consideration may also limit structural applications. Settlement of underlayers should be considered for coastal projects (coastal structures or sand nourishment) in this segment. Specific strategies for this segment are presented in Figure D.10-34.

The erosional segment labeled with a continuous red line in Figure D.10-33 should be restored with sediment and periodic nourishment. Nourishment in this segment should consist of a seaward protective berm (150 ft wide design berm), landward dunes with elevation ranging from 4-7 ft, and vegetative planting of dune species. Structures may be employed to reduce maintenance costs when the conditions set forth in Chapter 10 are met. Monitoring project performance after construction (two to five-year intervals) is necessary to define coastal segments where subsequent renourishment is necessary.

Sand searches of incised/ infilled paleo-channels should be conducted to identify local borrow areas. These investigations should include: (1.) coarsely spaced regional seismic surveys, (2.) mapping of incised channels that show potential for sand, (3.) widely spaced vibracores, (4.) development of a sand/GIS database for offshore sand sources, and (5.) selection of channels for further detailed geophysical/geotechnical (closely spaced seismic investigations) surveys to define borrow areas.

The Coast 2050 plan recommended the installation of bypassing structures at the Mermentau River jetties and the Calcasieu Pass jetties. However, because most of the sediment that accumulates updrift of these structures is silt and clay, the efficiency of such bypassing on mitigation of downdrift erosion is questionable. Bypassing structures may not be as successful as the introduction of new sand that has been dredged offshore.

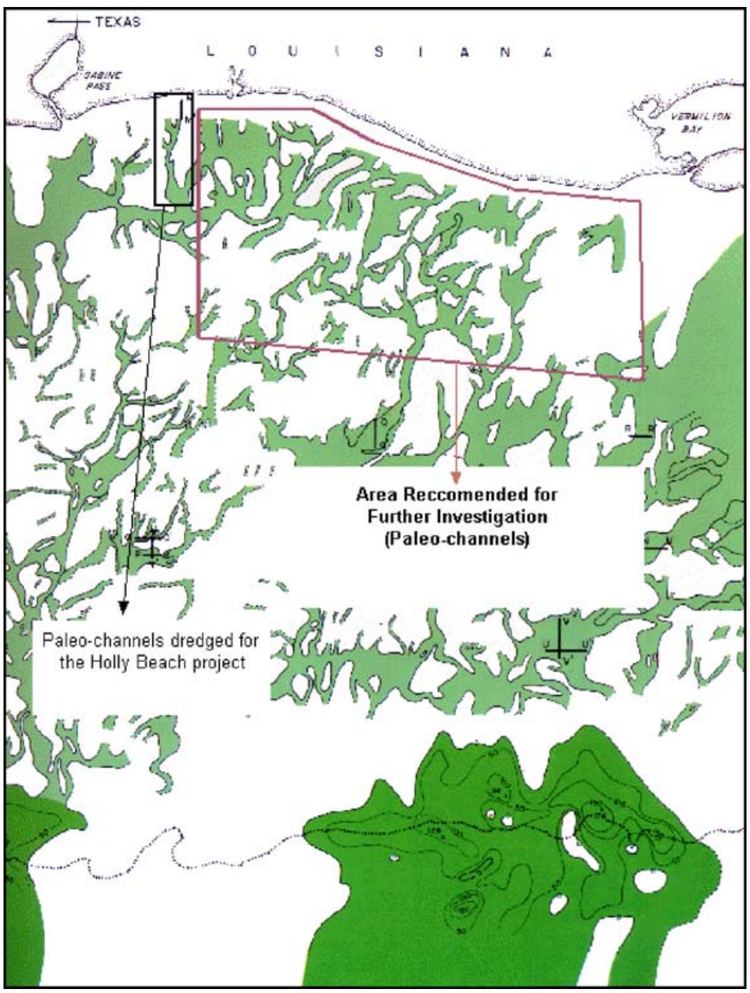

Figure D.10-33. Incised paleo-channels on the western Louisiana shelf (Berryhill 1986).

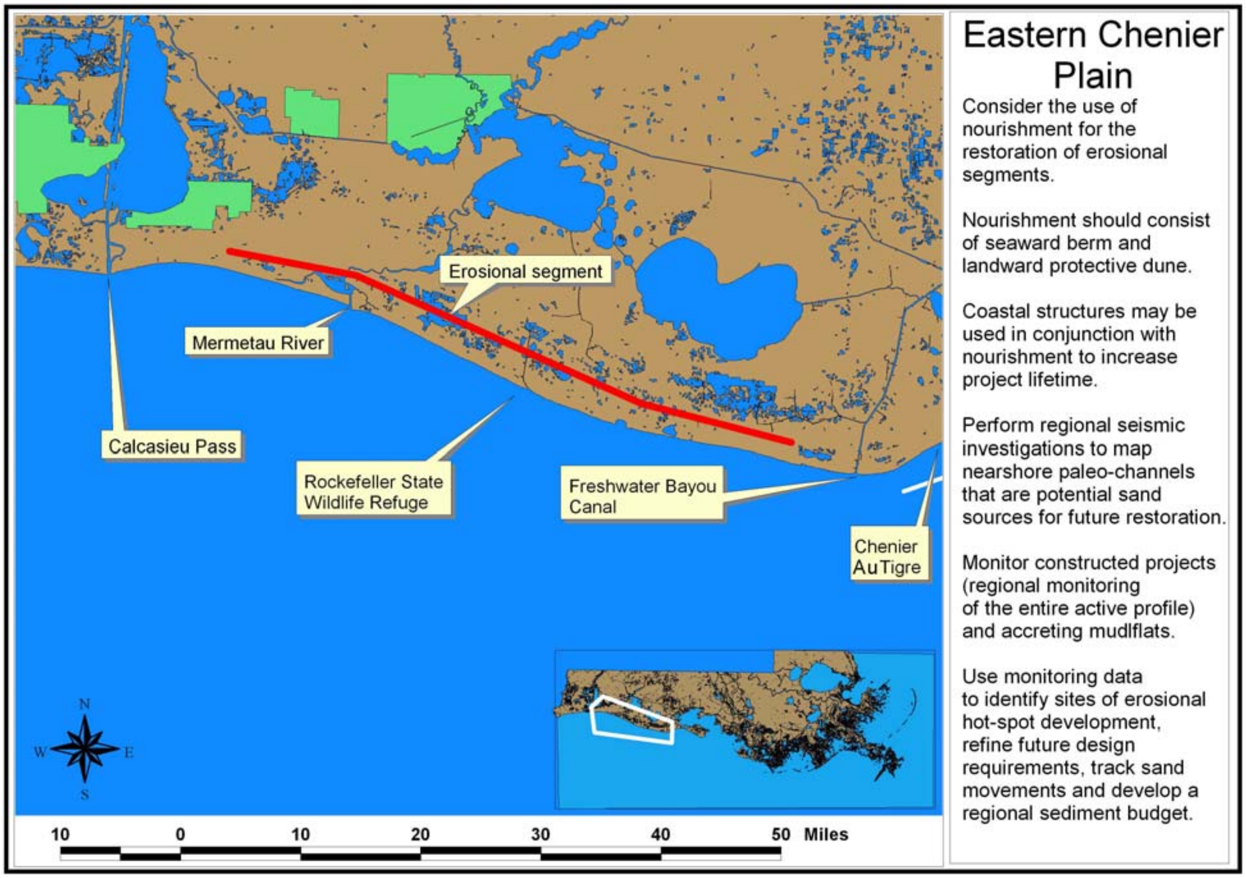

Figure D.10-34. Proposed management practices for the coastal segment located between Point Au Fer and Freshwater Bayou.

10.9.6 Volumetric Densities

Estimated volumetric needs for restoration of erosional segments on the Gulf shoreline, from Freshwater Bayou to Calcasieu Pass are shown in Table D.10-22. Because this area has large amounts of cohesive segments on both the Gulf and bayside shorelines, geotechnical studies to account for settling of the substrate after construction with sand overburden may be required and included in the design considerations. Initial construction volumes correspond to a stabilized design for this segment as long as maintenance is provided. Volumes are about 70% less than what was indicated for the stabilized design of the barrier islands because there is no marsh component, lower dune heights are required (e.g. 4-6 ft), and the area is subject to a milder wave climate.

10.9.7 Potential Sand Sources

Distant sand sources for these areas include the Sabine Banks located westward. Previously mapped incised paleo-river valleys (Berryhill 1986; Penland 2003; Figure D.10-33) may contain large quantities of local sediment sources that can be used at lower cost than distant sources.

Table D.10-22. Estimated volume needs for initial construction (retreat design) and maintenance 9advanced fill0 of restored areas on the coastal segment located between Freshwater Bayou and Calcasieu Pass.

	Initial Construction (cy/ft)	Advanced fill (cy/ft)	Total (cy/ft)
Calcasieu Pass to Old Mermentau River	No project recommended		
Old Mermentau River to Rockefeller Refuge West	50	45	95
Rockefeller Refuge West to Rockefeller Refuge East	50	82	132
Rockefeller Refuge East to Mulberry Island	50	44	94
Mulberry Island to Freshwater Bayou	No project recommended		

10.10 Subprovince 4, Calcasieu-Sabine Shoreline

10.10.1 Geographical Location

The Louisiana coast from Calcasieu Pass to Sabine Pass is located on the western end of the Chenier Plain. This segment is delimited by Sabine Pass and the Louisiana-Texas border to the west and by Calcasieu Pass to the east (Figure D.10-35).

10.10.2 Geological Inheritance and General Geomorphology

The Chenier Plain area between Calcasieu Pass and Sabine Pass is characterized by the presence of many small shallow ponds, marshes, and mudflats with alternating or coalescing shore-parallel ridges composed of sandy sediments and shell fragments (chenier ridges) (Figure D.10-32). The Chenier Plain of west Louisiana is a delta margin deposit that was formed at about 3,000 to 4,000 YBP. The chenier ridges that compose the plain are about 8 to 10 feet high and easy to identify from aerial photographs since the vegetative cover is distinctly different than the adjacent marsh vegetation. The Gulf shoreline in this area is closely linked to the formation of the Chenier Plain as beach sediments generally originate from the re-working of older cheniers.

10.10.3 Shoreline Change Rates

The majority of the shoreline from Calcasieu Pass to Sabine Pass is advancing, with two principal areas of erosion (Byrnes and McBride 1995): (1.) the first four to five miles of shoreline west of Calcasieu Pass, and (2.) the area west of Holly Beach along Highway 82 to west of the Gulf Breeze subdivision (Peveto Beach). The western five to ten miles updrift from Sabine Pass have been historically accretional or stable. This area is primarily composed of fine sediments (silts and clays), as sandy supply to this segment is very limited. The most probable sources of fine sediments creating the accretion observed east of Sabine Pass are the Mississippi/Atchafalaya mud-streams that are captured by the Sabine jetties.

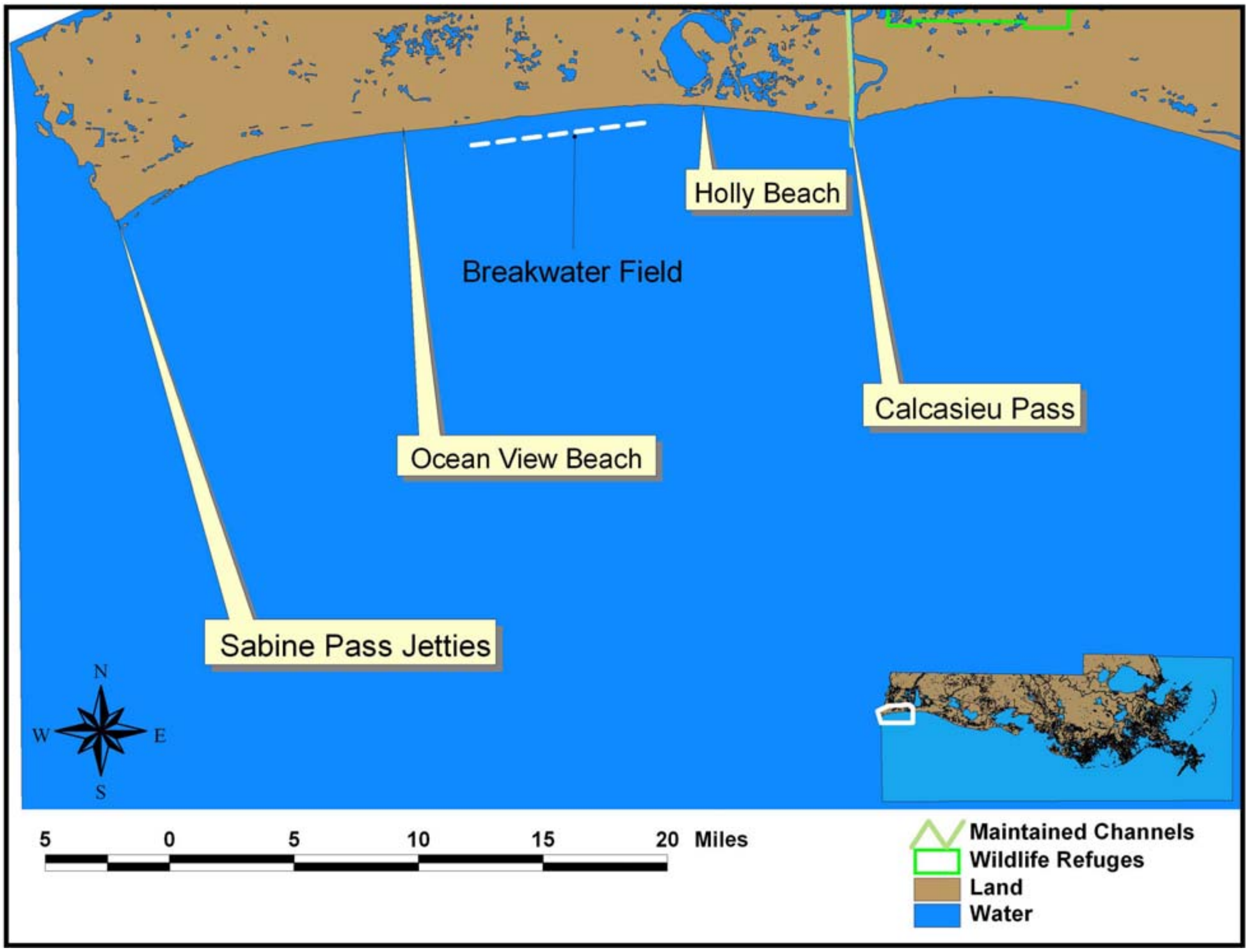

Figure D.10-35. Geographic location of the western Chenier shoreline.

Comparison of long- and short-term retreat rates for the Gulf shoreline in this coastal reach (Table D.10-23) show that: (1.) accretion rates have significantly increased west of Ocean View Beach (from 1.2 ft/yr to 12.9 ft/yr), (2.) shoreline change rates have been maintained almost constant between Ocean View and Holly Beach (from -4.3 ft/yr to -5.1 ft/yr), and (3.) shoreline retreat rates increase west of Calcasieu Pass to Holly Beach (from -0.1 ft/yr to -4.2 ft/yr). Considering that the beach in front of the Holly Beach community (about 8.5 miles west of Calcasieu Pass) has maintained a relatively stable shoreline in the last couple of decades, the retreat rates of the erosional segment (first five miles downdrift of Calcasieu Pass) may be even higher. Byrnes and McBride (1995) described that at about 1.8 miles west of Calcasieu Pass, the retreat rates reached a peak of about 9 ft/yr from 1983 to 1996.

10.10.4 Current Human Use and Previous Projects

CPE (2001) demonstrated the effects of erosion in the area west of Calcasieu Pass as the littoral drift increases from zero at the pass to about 50,000 cy/yr in Holly Beach. The major project constructed in the Sabine-Calcasieu coastal areas was the Holly Beach breakwater enhancement and sand management project (CWPPRA CS-31) (Figure D.10-36). The project was located at Constance beach, about one mile east of Ocean View beach and about two miles west of the Holly Beach community. The project consisted of enhancing the performance of 85 segmented breakwaters with beach fill placement and was designed to include 10 years of advanced fill nourishment.

Table D.10-23. Long-term (1985-1998) and short-term (1983-1994) Gulf shoreline changes for western Chenier Plain (Penland et al. 2003)

	1985 -1998	1883-1994
Sabine Pass to Ocean View Beach	1.2	12.9
Ocean View Beach to Holly Beach	-4.3	-5.1
Holly Beach to Calcasieu Pass	-0.1	-4.2

Figure D.10-36. Construction of the Holly Beach project. Note the dredge delivery pipes on the upper portion of the photograph.

10.10.5 Identification of Best Strategies for the Area

Restoration strategies proposed this area are summarized in Figure D.10-37 and include monitoring the performance of the Holly Beach project, re-nourishing when the advanced fill has eroded (about 10 years from initial construction), and initial nourishment for the first five miles downdrift of Calcasieu Pass.

Bypassing sediment at Calcasieu Pass has been considered in previous plans, however, the majority of the dredge spoil from the navigation channel is fine sediments (silts and clays), and the updrift (east) shoreline is also dominated by fines. Therefore, bypassing muds and clays may not be cost-effective or as beneficial as the introduction of new sediments from offshore. Protection in this area would require the introduction of new sediments into the littoral system in order to offset the drift gradient measured by CPE (2000). Therefore, construction of a protective beach berm and dune with advanced fill would be the most appropriate alternative.

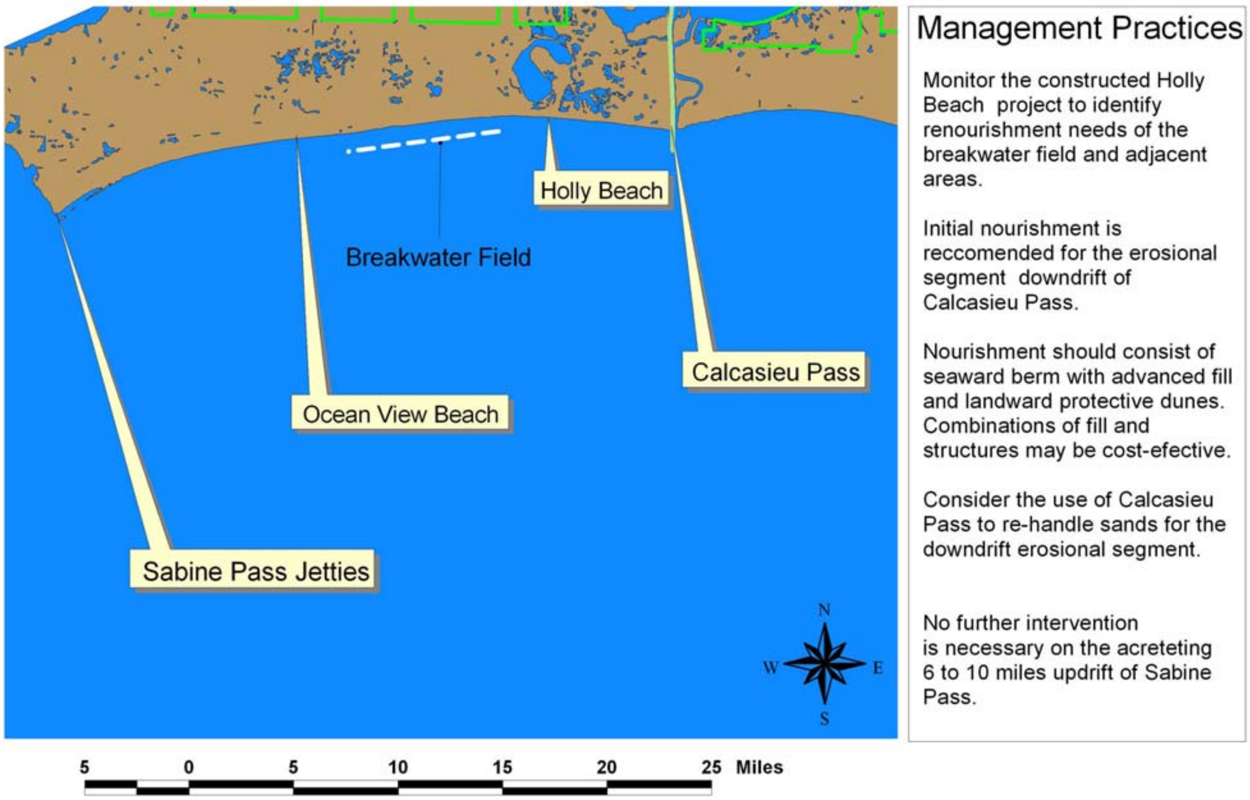

Figure D.10-37. Proposed management strategies for the western Chenier shoreline.

In this geomorphic setting, sand could best be delivered by hopper dredge to the navigation channel and delivered by re-handling over the jetty with booster or pipeline dredges. Since the cost of delivery sand to the site may be expensive, incorporation of breakwaters or other structures (e.g. T-head groins) may be cost effective.

The design considerations incorporated into the Holly beach project (see CPE 2000) may be adopted in other nourishment projects to be undertaken in the area. However, volumetric densities will be higher than what was employed by CPE (2000) (65-70 cy/ft) because of the absence of a breakwater field in the other areas. In nourishing additional sections of the Sabine-Calcasieu coast, local geomorphological and hydrologic features should be considered. There are several small inlets/passes in this region. Some of the passes are bayou entrances that open during times of heavy rains and close during dry periods. These bayous cut through the dune system and should be preserved since they are hydraulically (and ecologically) connected to the adjacent marshes. No further intervention appears to be necessary in the accreting 5-10 miles western boundary region (between Ocean View beach and Sabine Pass). This area should not be considered for restoration.

10.10.6 Determination of Volumetric Requirements and Costs

Volumetric requirements for this coastal segment were calculated based on: (1.) the littoral drift analysis of CPE (2000) for the Ocean View to Holly Beach breakwater segment, and (2.) the erosion rates of Byrnes and Mc Bride (1995) and Penland et al. (2003) for the five miles downdrift of Calcasieu Pass. CPE (2000) estimated that the erosion rate in front of the breakwater field west of Holly Beach was on the order of about 1.1 cy/ft/yr and increased slightly to the west. As a result, the advanced fill requirement for a renourishment project with a ten year lifetime will be approximately 12 cy/ft (Table D.10-24). Monitoring of actual project performance will permit refinement of this number and definition of areas that need greater renourishment density within the breakwater field. In the area west of Calcasieu Pass, an initial construction fill of 50 cy/ft with an advanced fill of 18 cy/f (1.8/cy/ft/yr) is suggested.

Table D.10-24. Proposed volumetric densities 9intial fill and advanced fill) in cy/ft for the restoration of the west chenier shoreline.

	Initial Construction (cy/ft)	Advanced fill (cy/ft)	Total
Sabine Pass to Ocean View Beach	No project recommended		
Ocean View Beach to Holly Beach	0	12	12
Downdrift of Calcasieu Pass	50	18	68

10.10.7 Potential Sand Sources

Known sand sources suitable for beach restoration in this area (CPE 2001) are the relict Peveto Channel borrow area (used for Holly Beach in 2002,: Figure D.10-38), and other paleo channels mapped in the area (Berryhill 1986; Figure D.10-33) that need to be further surveyed. The Sabine banks is a distant source that was bid but not used in the Holly Beach project. This area contains large amounts of sands for the long-term maintenance of the western Chenier coast.

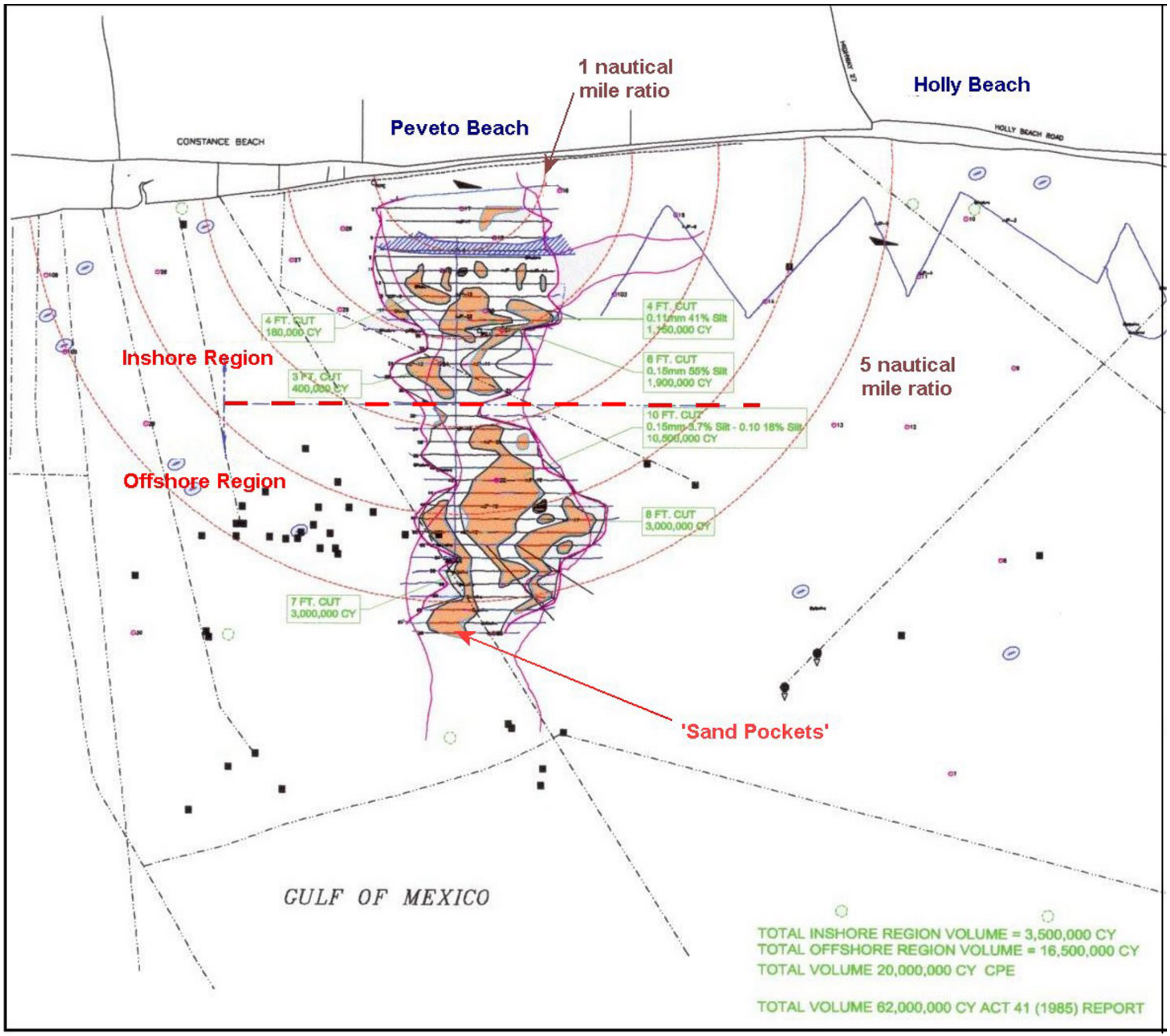

Figure D.10-38. Incised paleo-river channel located on the western Louisiana shelf offshore Peveto beach. The deposit consists of fine sand overburden by silt and stiff clay and was dredged for the Holly Beach breakwater enhancement project. Overburden fine sediments (silts and clays) were removed and side-cast to a bottom disposal location.